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VOLUME 4 NUMBER 1 JANUARY 1974

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Cover design, by William N. Welsh, reflects NOAA's determination, expressed in Administrator's Message (opposite page) to do an outstanding job in the conservation of the nation's energy.

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U.S. DEPARTMENT OF COMMERCE
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A Message From the Administrator

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ROBERT M. WHITE

Only a few months ago, the notion of an energy shortage was perceived by most Americans in terms of dim and unthreatening abstraction. Today, that shortage is here—a reality which involves keeping men and women at work, children and the elderly warm.

For NOAA, energy conservation must become a compelling, daily concern, both as users of energy and through the many services we render to the public.

I have appointed Rear Admiral Harley D. Nygren, Director of the NOAA Corps, as Energy Conservation Project Manager. Admiral Nygren will work with the NOAA family from top to bottom to assure careful stewardship of this vital resource. No logical saving of energy is too insignificant to attain, from fuel economies in the operation of ships and aircraft to the turning off of 25-watt light bulbs.

In its role as an environmental agency, NOAA has already made valuable contributions to the national energy conservation drive. As early as last November, the Environmental Data Service alerted the Nation to the possibility of a need for 1.1 percent more fuel consumption this year than last. Its degree-day data has been found useful from the Executive Office of the President, to Department of the Interior fuel allocation planners, to more than 200 National Weather Service offices. EDS data is at work almost everywhere the energy problem is being tackled—where oil and gas leases and exploration are concerned, where offshore nuclear plants are under consideration, where the spectre of brownouts is under study, and where solar and wind power are being probed, to mention a few areas.

No Federal agency could be deeper in the fabric of the energy effort than the National Weather Service. Its aviation, shipping, travelers', hydrological and general forecasts are vital to the day-to-day management of energy. Its experimental three-month outlook, made public on a large scale for the first time this season, gave each region a tentative indication of temperature expectations.

The National Ocean Survey is working with industry to extend geodetic control offshore in the Gulf of Mexico to facilitate oil development, and is providing new bathymetric charts of the resource-rich Gulf to the Bureau of Land Management. In Alaska's Cook Inlet, NOS is updating its information for energy development.

An important part of the national effort to increase energy resources will be concentrated in the coastal zone, at least for the near future. NOAA's new Office of Coastal Environment, which is responsible for administration of the Coastal Zone Management Act will play a major role in assuring that state plans for balanced management of our coastal zones are prepared which will produce power, and preserve the environment. Many of the research activities of the National Sea Grant Program and of our Environmental Research Laboratories will have important impact on the way we handle our energy problems. Not to go on endlessly, every NOAA component is in the fight.

Energy conservation will be a way of life with us from now on. Perhaps it was overdue. Certain it is that nothing will impress the authors of the energy crisis more forcefully than to see the people of this nation exhibit the strength and resourcefulness to bring us through the winter with courage, style, and power to spare.

And to learn, once again, that a motivated American is anything but soft.

Getting Through The Winter

NOAA data guides the nation's fuel planners

BY PATRICK HUGHES

With the nation confronting an energy crisis, a little-known statistic computed by NOAA—the heating degree day—has suddenly emerged from relative obscurity to prominence. In future, it may become as familiar and as important to the public as the government's periodic reports on the cost of living.

Federal offices and departments responsible for coping with heating fuel shortages are making extensive use of a special NOAA report on past degree-day patterns in the United States and of weekly figures on nationwide degree-day accumulations.

In the summer of 1973, the Energy Policy Office of the Executive Office of the President asked NOAA to determine the extent to which the national demand for heating fuels this winter would depend on the weather. A special NOAA Task Group was formed to undertake the study.

Because temperature is the critical weather element, it was mutually agreed that a straightforward probability analysis of the nation-wide variability of seasonal total "heating degree days,"—a temperature-related measure of fuel demand widely used in industry—would provide a valuable national planning guide for the approaching winter.

Dr. J. Murray Mitchell of NOAA's Environmental Data Service, an expert on the application of climatic data to national problems, headed the Group. Other members were Dr. Richard E. Felch of the National Weather Service's Agricultural Meteorology Support Service Program; Dr. Donald L. Gilman of the Weather Service's Extended Forecast Division; Frank T. Quinlan, of the Environmental Data Service's National Climatic Center in Ashville, N.C.; and Dr. Ralph M. Rotty, a National Academy of Sciences/National Research Council Senior

Menace of cold snaps combined with oil shortages is real to thousands of Americans. Careful use of home heating fuel will help insure enough to keep the nation warm.

In this Associated Press Wirephoto, Mrs. Alfred Pauly stands by her plastic-clad house near Belle Plaine, Minnesota. Cost of the giant wrapping project totalled $5.60. The Paulys plan to run their thermostat considerably lower this winter.

Research Associate assigned to the Air Resources Laboratories of NOAA's Environmental Research Laboratories. (Dr. Rotty is on leave of absence from his post as Dean of Engineering at Old Dominion University in Norfolk, Va.)

The Task Group's report was presented to the Energy Policy Office on September 18, 1973, and has since become a key planning guide for the heating oil allocation program now being carried out by the U.S. Department of the Interior. The allocation program is based partly on heating degree-day data and analyses, provided jointly by NOAA's National Weather Service and Environmental Data Service.

Heating engineers have found that when the outside daily mean temperature is 65 degrees or higher, most homes and buildings require no heat to maintain comfortable indoor temperatures (the daily mean is computed by averaging together the highest and lowest temperatures reached during the day). This observation is the basis of the "degree day" concept: for each degree the daily mean temperature is below 65 degrees, you accumulate one heating degree day. Thus, if the daily mean temperature for your city is 62, 3 degree days accumulate for the 24-hour period. For every degree day, an additional amount of fuel is required to maintain a comfortable indoor temperature.

In their study, the NOAA scientists used monthly mean temperatures from July 1931 through June 1973 recorded by thousands of cooperative weather observers across the United States (excluding Alaska and Hawaii) to calculate national degree-day data. These temperature observations are on file in the Environmental Data Service's National Climatic Center (NCC) in Asheville, N.C.

The Task Group first calculated monthly and seasonal total heating-degree day values for each State for each of the 42 heating seasons (July through June) from 1931/32 through 1972/73. The values were weighted to favor more populous areas, such as large cities, where cold weather would produce the heaviest fuel demand.

Next, the State heating-degree day totals were averaged to produce national average heating degree-day totals for the 42 seasons for each of five heating fuel categories: (1) all fuels (including coal, wood, etc.), (2) gas, (3) oil, (4) electricity, and (5) Liquefied Petroleum Gas (LPG, chiefly propane). The resulting series of 42 national average heating-degree day totals for each category was then treated as a direct measure of the relative variations of total national heating fuel demand in that category, assuming a constant economy.

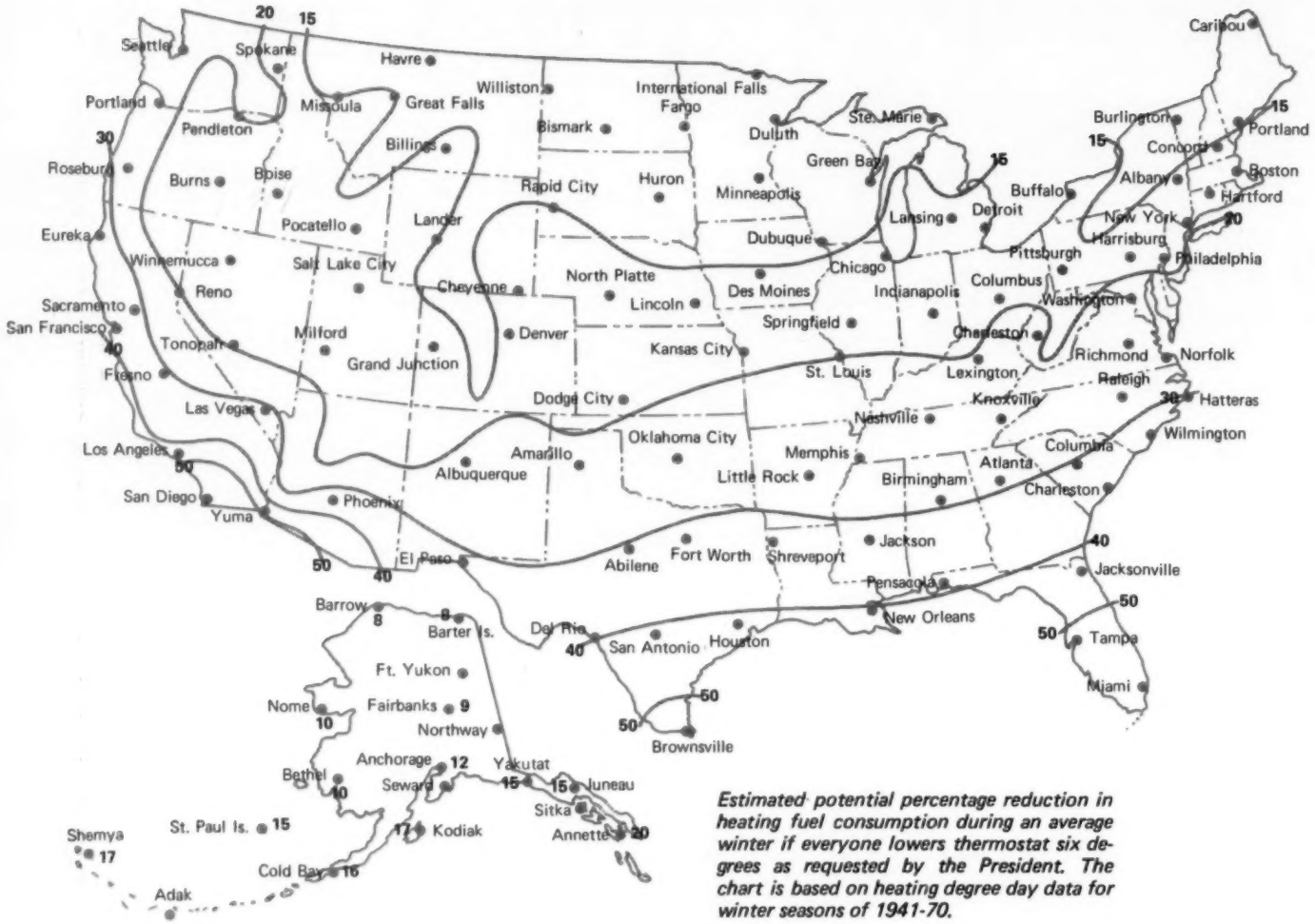
Finally, the 42 values in each of the five series were used to construct statistical models to assess the probabilities of extreme fuel demands in an arbitrarily chosen heating season, such as the current season. Following this approach, it was possible to define the weather (temperature) influence on national heating-fuel demand independent of the long-term growth of demand attributable to economic, population, and technological trends.

The results of the study show that national average heating degree-days values are highest when weighted for oil and lowest when weighted for electricity. Values for gas are also relatively high, and those for LPG relatively low. These relationships reflect the fact that the principal heating fuel used varies from one part of the country to another. The highest demand for oil, for example, is concentrated in the Northeast and upper Midwest. Inasmuch as oil is one of the heating fuels currently in shortest supply, it is some cause for concern that a disproportionately large number of Americans who rely on this fuel live in the coldest parts of the country, where shortages could cause particularly severe hardships. In addition, many of the states involved experience unusually large climatic variations from year to year; thus, the climatological probability of a winter sufficiently severe to increase significantly the demand for heating oil is higher in these states than in others.

Nationally, the study shows that, with few exceptions, the heating seasons since 1957/58 have been colder than those from 1931/32 through 1956/57. One exception was the warm winter of 1971/72. By far the warmest winter during the period was that of 1931/32, and several winters in the early 1950's were relatively warm, but very few since then. It remains to be seen whether this latter-day cooling is a persistent, long-term climatic trend.

Through statistical modeling, the Task Group concluded that in only one year in 100 would the total national demand for heating fuels be expected to exceed its 42-year average by 10 percent, and in only one year in 5 would the total demand exceed the average by 5 percent (these probabilities refer only to the effects of temperature variability, and do not consider changes in demand due to economic, population, or technological trends).

In general, then, the NOAA study shows the effect of weather on total national demand for heating fuels to be a 5-percent



Estimated potential percentage reduction in heating fuel consumption during an average winter if everyone lowers thermostat six degrees as requested by the President. The chart is based on heating degree day data for winter seasons of 1941-70.

problem on a time scale of decades, and a 10-percent problem on a time scale of centuries. This assessment is strictly valid, however, only if no systematic changes in climate occur from decade to decade and century to century. Unfortunately, available evidence strongly indicates that significant climatic changes do take place on these time scales; depending on the future direction and magnitude of such changes, the above conclusions could turn out to be significantly optimistic or pessimistic as long-term guides. As statements of probability for one or more winters in the immediate future, however, they are unlikely to be seriously compromised by climatic changes.

As was expected, the study shows that when one section of the country is colder than average, other sections tend to be warmer than average. Therefore, when national heating-fuel demand is higher than average, the excess demand is quite likely to be centered in one area of the Nation, while near average or less than average demand will occur in other areas. Because of the importance of this phenomenon in national fuel allocation planning, the NOAA Task Group also analyzed weather-related heating fuel demand on a regional basis.

To accomplish this, they computed average heating-degree day values for each of the nine regions of the country used by the Bureau of the Census and the gas industry, namely: New England, middle Atlantic, east north central, west north central, south Atlantic, east south central, west south central, mountain, and Pacific states. Probability assessments of extreme heating-fuel demands were also derived. As expected, their analyses show that probable extreme variations in regional fuel demand are considerably greater than the nationwide average variations. As indicated above, however, not all regions would be likely to be extremely cold at the same time.

The study indicates that fuel demands for all areas east of the Rockies tend to vary more or less in parallel, as they also do for the Pacific and Rocky Mountain regions. Variations in fuel demand in areas east of the Rockies, however, tend to be opposite those in Pacific and mountain regions; when demand is high in one area, it is usually relatively low in the other. This is consistent with meteorological experience, wherein climatic anomalies tend to be opposite on either side of the Rockies. There is also a slight tendency for climatic variations to differ considerably in northern and southern States.

On the basis of the study, it appears that a fairly reliable estimate can be made of the chances of unusual weather-related heating fuel demands during the current heating season, both nationally and regionally. Such a risk assessment is not a forecast, but rather a statement of climatic odds, since it "predicts" the same probabilities for any given heating season. This assessment should be reasonably reliable until such time in the relatively remote future when the cumulative influence of systematic climatic change may outdate it. At that time, a similar procedure could be followed to generate new probabilities to take such change into consideration.

The degree-day data were viewed by the Task Group in another way to indicate the most probable heating fuel demand in the 1973/74 season, both nationally and regionally. In the absence of climatic trends, the most probable national fuel demand (all fuels) this season would be the average demand of the past 42 years, which works out to be about 1.8 percent less than the actual demand of last season. However, as noted earlier, the climatic record in recent

years shows a rather persistent trend toward higher demand (colder weather). Whether or not this trend will continue cannot be predicted. If it should continue, then the experience of the last 10 years of record would be a better measure of the most probable 1973/74 demand than the experience of all 42 years of record available to the Task Group. On this basis, the total national demand for this season would be about 1.1 percent *higher* than last year.

In summary, the Task Group study suggests that if the Nation had the means to boost heating-fuel production capacity by several percent over current demand, it would be able to get comfortably through all but the most extreme winter cold, such as is experienced only once or twice a century.

On October 5, 1973, Eric Zausner, Deputy Assistant Secretary of the Interior, wrote to NOAA and suggested that the Task Group report and the data base supporting it be used to develop a national index to monitor the current and cumulative impact of weather on heating oil demand during the approaching winter. He noted that weather variations would have to be followed very closely to permit quick action to minimize detrimental effects of potential shortages.

On October 17, in response to this request, Dr. Mitchell and other representatives from NOAA's Environmental Data Service and National Weather Service met with Dr. William Hogan, Chief of the Modeling Division of the Department of the Interior's Office of Energy Data and Analysis (OEDA). During this meeting an interagency program was developed whereby heating-degree day data and analyses provided by NOAA would be used by OEDA as a real-time indicator of the geographical distribution of national heating oil demand to guide the Department's allocation program.

Weekly degree-day data and analyses for more than 200 first-order National Weather Service offices across the country are the primary real-time data input, and are being regularly forwarded to Interior in both tabular and map form. For its part, the Environmental Data Service has provided two historical data references as bench marks against which to measure the progress of the current season on a weekly basis. The first baseline reference is the day-by-day degree-day averages or "normals" for the period 1940–71 (climatological normals are internationally defined as 30-year averages); the second is the actual degree day data experience for the 1972/73 heating season. All of these contributions are appropriately weighted by DOI to reflect fuel consumption patterns and the final values used to determine national heating-oil demand on a week-to-week basis.

The specific input provided by NOAA each Monday consists of accumulated degree day data for the previous week and for the heating season to date (since July 1, 1973). These are accompanied by three national maps (prepared by NWS' National national maps(prepared by NWS' National Meteorological Center in Suitland, Md.) which show the degree-day totals for the present season to date compared to the totals last season to the same date; the past week compared to the normal week for the same time of year; and the present season to date compared to the normal season to date.

EDS is also constructing and regularly updating monthly values for the present season to compare with the statistics developed in the Task Group study and, using these values, is providing a month-by-month progress report on the deviation of this year's demand from the normal seasonal demand.

This year, initial heating oil allocations were based on last year's experience. Subsequent allocations, however, are being adjusted according to degree day statistics and fuel supply indicators as the heating season progresses. In commenting on this cooperative effort, Dr. Mitchell observes that it or a successor program is likely to be with us for a long time to come, since the gap between our fuel demand and our fuel supply is a longterm problem which will remain a fact of life for the foreseeable future.

As the study shows, however, the coldest winter likely in 100 years would generate a demand for approximately 10 percent more fuel than we used last year; for the coldest average weather in 10 years, about 6 percent more. President Nixon has already urged the Nation to turn its collective thermostat down 6 degrees. If this were done, it would reduce our heating fuel consumption this winter by about 15 percent—or enough for us to cope rather well with the weather—even if it turns out to be the coldest winter of the century. □

Commerce Department has been assigned the lead in promotion of energy conservation. Secretary Frederick B. Dent inaugurates the program at Department press conference.

SHARK!

Fearsome creature of the deep, a shark accompanied by a rudder fish swims the ocean, wearing a tag which is visible at its dorsal fin.

BY ANN WEEKS

The shark is perhaps the world's least popular creature.

Detested and feared by all, the animal has been hunted down relentlessly, and historically has been the victim of the most fiendish torture the human mind can devise.

The cry **"shark!" "tiburon!", "requin!"** unfailingly galvanizes most swimmers into a headlong sprint to the safety of dry land. The very thought of a shark nearby seems to evoke an almost superstitious terror in humans the world over.

Does this legendary creature—whose ancestors were successfully adapting to earth's demands more than 150 million years before man arrived—deserve its reputation? Most experts—scientists, divers, some fishermen—say no, not under ordinary circumstances. (Ordinary circumstances exclude such phenomena as the shark "feeding frenzy," in which the creatures gorge themselves without restraint on any and all objects within reach. Apparently, also, some large sharks capriciously single out man as their prey on rare occasions. One white shark was blamed for four human fatalities off New Jersey in 1916, and another for several attacks and one death in New England in 1936.)

Disposition aside, however, sharks are many things to many people:

- to marine scientists they are "superior biological organisms" that may eventually be instrumental in the gaining of a better understanding of ocean ecology;
- to students of evolutionary processes, sharks are "a triumph of adaptation to the harsh demands of life on earth";
- to many people throughout the world, the shark is an important source of nutrition;
- to a growing band of U.S. sportsmen the shark—particularly the high-flying mako—is an eagerly sought and greatly prized game fish.

And to John G. Casey, a biologist at the National Marine Fisheries Service Laboratory in Narragansett, Rhode Island, the shark is a fascinating creature to be tracked, tagged, and studied by the thousands in the world's most extensive program of its kind.

Casey's project is part of Narragansett's broader program of biological research and of the assessment and management of marine resources off U.S. shores, under the direction of NMFS's Northeast Fisheries Center at Woods Hole, Massachusetts.

Emphasis in the shark-tagging project is

on the acquisition and study of data that may reveal migration patterns, age, growth, and reproduction processes, abundance of stocks, and other factors involving marine life cycles. Most of the required data are collected through the cooperation of the big-game shark fishermen of the northeastern states.

NOAA believes investigations of shark populations can yield information important to marine science, to sport and commercial fisheries, and perhaps to economic planners. Though man's attention has been captured by large sharks since the beginning of time, surprisingly little exact knowledge about shark species is available.

For instance, nobody knows how long most species of shark live or how fast they grow, and information about how far and fast different sharks travel is imprecise. An accurate census of shark populations has never been taken. Therefore their effect on the marine environment cannot be measured, and it is not known whether increases or decreases in shark numbers influence the availability of other species.

The shark investigation began in 1963, under the direction of Dr. Lionel Walford, then in charge of the Bureau of Sport Fisheries and Wildlife laboratory at Sandy Hook, New Jersey, (now part of NMFS) who saw the advantages to both the scientific community and sport fishermen if the two pursued a cooperative investigation of Atlantic sharks. Work began from a research vessel donated by the commercial fishing industry.

The program's earliest objective was to survey coastal waters from New York to Delaware (the Mid-Atlantic Bight), to determine whether reported large stocks of sharks, some ranked as game fish, were available to sport fishermen. (The International Gamefish Association classifies seven sharks as game fish—mako, blue, porbeagle, white, thresher, tiger, and sawfish.)

Once the surveys had confirmed the existence of an abundant population, the next objective became the establishment of an efficient system for catching, tagging, and releasing the fish. Tuna tags were used at first, but proved not sturdy enough to penetrate the tough hides of sharks. (The hide is actually made of row upon row of tiny teeth.) Another early problem was to teach sportsmen to become experts at the identification of species seen or tagged—not an easy task, considering that at least 250 species of shark exist in the world ocean and that on the U.S. East Coast several species are almost identical in appearance. A new kind of tag was developed to solve the first difficulty, and Mr. Casey's publication entitled "Anglers' Guide to Sharks of the Northeastern United States," (1964)—combined with personal instructions to anglers from NMFS scientists—helped with the second problem.

Casey's earliest marine experience was in Scuba diving which became his avocation in 1950, when he was 17 years old. Fishing and hunting have also been lifelong interests. After a four-year stint in the U.S.

Sandbar shark is maneuvered toward sling (upper left) to be taken toward deckside for tagging. In the sling (lower left), he is relatively motionless. He is lightly hooked—fishermen try to prevent internal injury. Above, tag is clamped to dorsal fin or on the animal's back in a quick, painless operation. Written instructions to finders stream out on plastic cord (not visible in photo). Below, undamaged shark, now wearing a lightly-colored tag, returns to sea.

John G. Casey, NOAA-NMFS biologist and chief of shark-tagging project, examines 14-foot Great White Shark taken off Montauk, N.Y. in 1963. It may, at 1500 pounds or more, be largest trophy fish ever landed on rod and reel in the Atlantic.

A tiger shark weighing about 1000 pounds about to be brought aboard a sport fishing boat. Each year, United States fishermen catch about 780,000 medium-to-large sized sharks.

Navy, Casey attended the University of Massachusetts, where he earned his degree in wildlife management, intending to pursue a career in fields involving the study of land animals and conservation. He was hired as a summer assistant in the Federal marine science laboratory at Woods Hole, Mass., in 1959, and as a full-time fisheries biologist at the Sandy Hook laboratory in 1960. Shortly thereafter he began to specialize in study of the large sharks of the Atlantic Ocean.

The shark investigation gathered steam and ever-increasing numbers of volunteers over the years, primarily from the sport fish community. Now hundreds of anglers are highly skilled in the handling and identification of the more than 11,000 sharks so far tagged and released. Tags consist of a small plastic capsule containing return instructions in five languages, embedded harmlessly in the shark's back. The colorful and highly visible adornment trails away from the fish as it swims.

"The fishermen serve as our eyes and ears over an area much too large to study on our own," said Casey. "Some of the fishermen have become so adept as scientific aides that we never have to question their reports. And it takes a lot of time and study to be able to detect some of the small, sometimes extremely subtle characteristics that distinguish lookalike species such as the white and mako sharks."

The cooperative program has spread into the Gulf States, Britain, Spain, and the Canary Islands. As support and interest grew, so did Casey's correspondence with hundreds of tagging volunteers seeking advice and instructions in regions far from the original sites off the northeast coast of the United States. He attends about six shark-fishing tournaments each year, and tries to provide regional tournament officials with forecasts of shark catches potentially available to game fishermen at different periods and in different locations. Assistance is given the project by various State officials and universities, private marine institutions, the commercial fishing industry, and the Canadian Government, to extend the area of investigation as widely as possible.

To date, about 11,600 sharks representing 29 species have been caught, tagged, and released. Tags from recaptured specimens number about 344, these from 15 species including blue, sandbar, and mako sharks. The maximum distance covered is 2,070 miles by a blue shark (New England to South America); the maximum time between tagging and recapture is more than 7½ years for a sandbar shark. Tags have been returned from commercial fishermen of 18 foreign countries (35 percent of total), and U.S. sport and commercial fishermen (65 percent).

Among the preliminary, but potentially significant, findings from tag returns are:

—that the blue shark is an inveterate traveler, moving 1,000 or more miles annually, from the Northeast U.S. coast to as far south as Guyana, and sometimes across the Atlantic;

—that blue sharks, mako sharks, and white marlin (and perhaps swordfish as well) follow similar migratory routes;

—that migratory routes of male, female, and juvenile segments of some shark populations differ and change as the sharks increase in size;

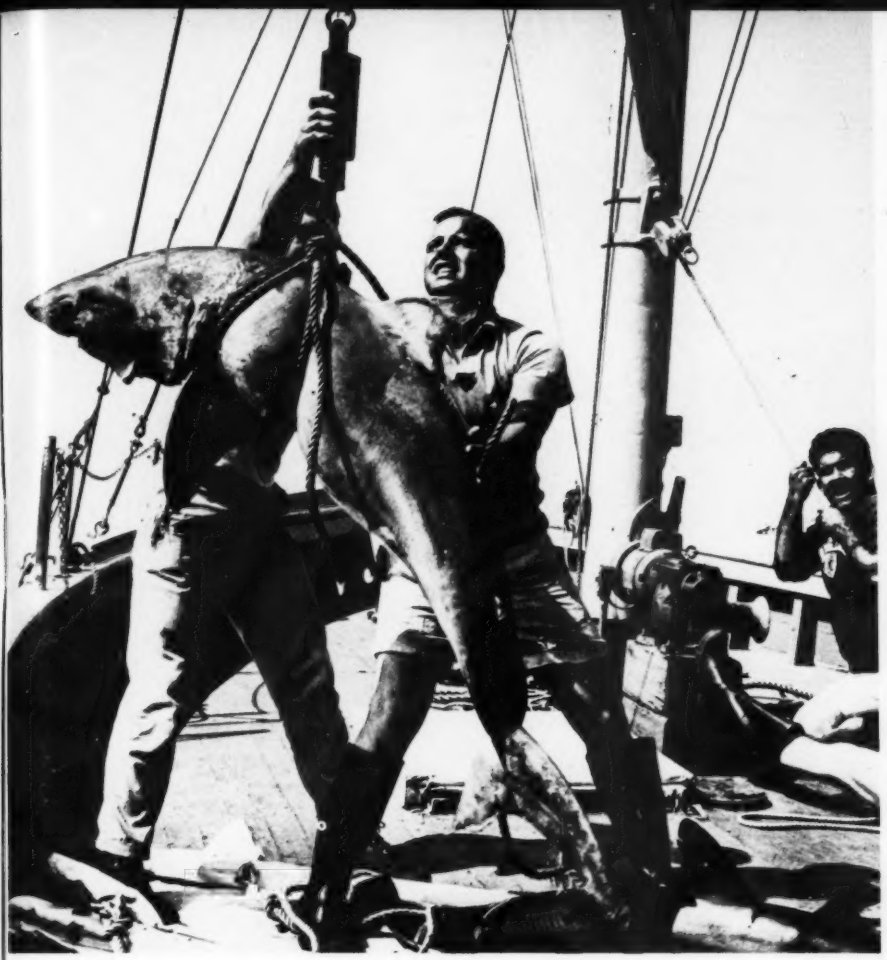
—that certain sharks seem to follow particular food or sport species on a feeding migration—mako with swordfish, porbeagles with mackerel, sandbar sharks with menhaden, makos with bluefish, and so on;

—that some sharks may be much longer lived than had been previously supposed. For example, a specimen tagged at three feet and estimated to be three to four years old, had grown only twenty inches and was still immature when recaptured after seven years at liberty. Another, tagged at six feet, showed no measurable growth seven years later.

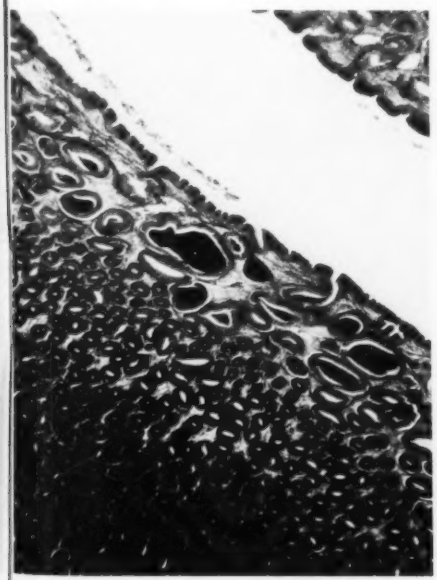
Project personnel add a dimension to their capabilities because, in addition to being highly trained biologists, all are expert divers. Mr. Casey has appeared in two shark-hunting documentaries seen on national television (one took place in Australian waters); another shark authority, Wes Pratt, participated in NOAA's FLARE project, an undersea investigation of coral-reef ecology off Florida in 1972. The third member, Charles Stillwell, operates as the back-up diver for the other two in various shark-related undersea work, including observation of sharks responses to tagging procedures.

One of the questions always put to divers who swim among sharks is: "What was your most alarming experience?" Casey replies that his particular moment of truth occurred not underwater but while he was aboard a commercial shark fishing trip off the eastern shore of Virginia. "It was at night," he said, "and we were taking a lot of sandbar sharks in the three- or four-foot range. Our only light came from a battery operated bulb on deck. At one point we had about ten sharks flopping around on deck, when one of them knocked out the battery and light. There we were in total darkness, not knowing when we might step into a mouthful of snapping teeth. Everyone jumped up on the gunwales and stayed there until one brave soul managed to grope around and somehow fix the light rig."

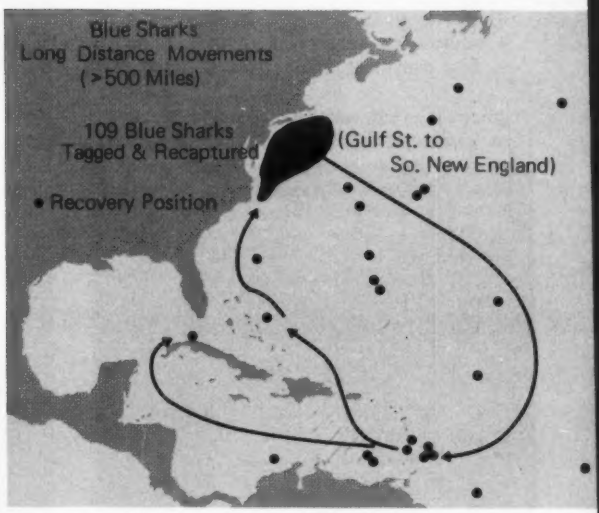
What about the shark as a potential market item for human consumption? Few members of the U.S. population have accepted sharkmeat as a regular part of their diet. However, mako shark is said to taste like swordfish; "steakfish," "grayfish," and "whitefish," have been used as euphemisms for sharkmeat; Europeans buy shark as "flake," and the English eat dogfish, a small shark, in their "fish and chip" dinners. (Many of thousands of U.S. military personnel stationed in Britain during World War II also ate and enjoyed the same fare.) Currently, yearly U.S. landings of shark for food purposes amount to about half a million pounds.

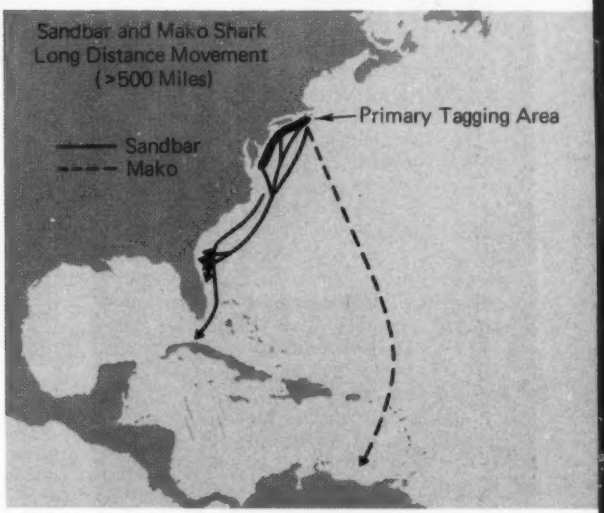


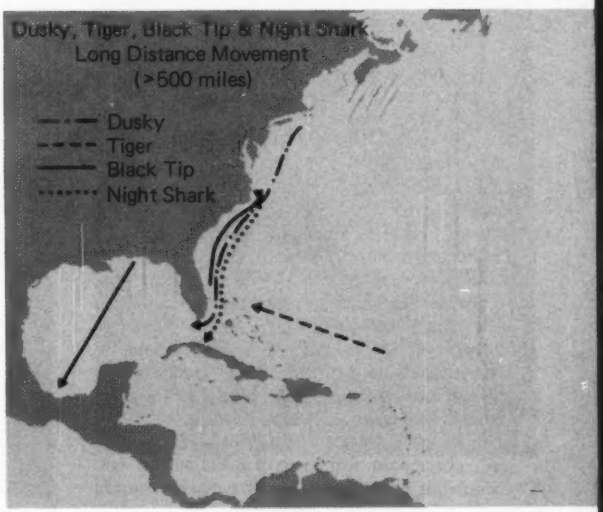
Securely trussed, a white shark comes aboard an NMFS research vessel. The species is one of 27 classified as possibly dangerous to man. In all, there are 250-300 species.



Above left: Highly magnified part of immature sandbar shark. Eggs will pass through white area, be fertilized, stored after mating. Small cells at left will eventually secrete egg cases. Above right: Again very highly magnified, longitudinal section through the ovary of a blue shark.







Sharks are inveterate, tireless travelers. The three maps above, from the top, show some of the peregrinations of the blue, sandbar and mako, and dusky, tiger, black tip and night sharks.

How Dangerous?

As a killer of humans, the shark is near the bottom of the scale, even lower than strikes by lightning. Worldwide, official records of unprovoked shark attacks show an average of only 26 per year over a 23-year period. Of the 23-year total, 29 per cent proved fatal. The chance of death by shark attack is perhaps one in a billion for the 10 million or more persons who swim off the beaches from Maine to Florida.

Seagoing scientists regard sharks as dangerous animals and treat them with respect, even though they work in close proximity to them underwater. Usually, they say, any abrupt or threatening move by a diver will cause a shark to retreat.

However, although they consider danger from sharks over-dramatized, authorities agree that the creature is, above all, unpredictable.

They offer the following safety measures for those in shark-polluted waters:

Stay out of the water if sharks are reported.

Always swim with a companion.

Do not enter or stay in the water if you are bleeding.

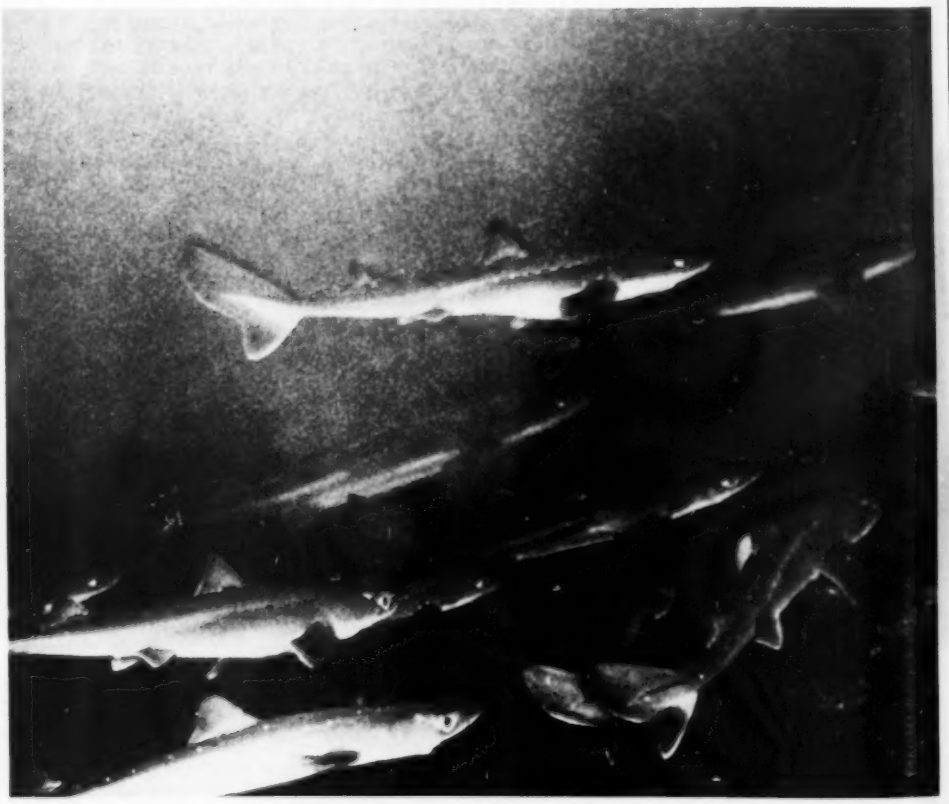
Avoid turbid, dirty water with poor visibility. Avoid swimming at night, especially in warm tropical waters.

Do not provoke sharks, even small ones. Many animals react aggressively to provocation, but sharks have bigger teeth than most.

Remove speared or struggling captive fish to a boat or shore immediately. Sharks are most predictable in one sense—they will almost certainly arrive quickly in the vicinity of a sounded, thrashing fish.

If you believe a shark is threatening, swim as rhythmically as possible to a safe haven. Panicky swimming is considered an attraction to shark attention.

Be careful about handling the head and jaws of a caught shark, even though it may appear dead. Many sharks take a long time to die, and have at times revived enough to do horrendous damage to careless handlers.



Above, whitetipped sharks and pilotfish photographed by Reginald M. Gooding from raft in Pacific. Note attached remora. At left, school of dogfish. At right, ravenous net eater attacks its dead prey.

Africans, Middle Easterners, Australians, and Orientals have no compunction about eating the animal under its own name and, in fact, traditionally catch and consume great quantities of several kinds of shark. The meat, being fat-free (sharks store all fat in their liver), represents a prime source of protein and is, in many regions, regarded as gourmet fare. As a matter of fact the NMFS shark group at Narragansett shares that notion, and sharkmeat is on its menu frequently. All prefer mako to other varieties, but state that blues, duskies, sandbars, porbeagles, and whites are also excellent. The men advise that young, small sharks (up to about a hundred pounds) are preferable to large tougher specimens, and that sharkmeat should be dressed and eaten as soon as possible after the shark has been caught. (Shark flesh tends to spoil more rapidly than some other fish because of a digestive peculiarity and nutritionists warn that shark liver is too rich for human consumption.) Some cooks prefer to soak sharkmeat in salt water or milk for several hours before cooking.

Mr. and Mrs. Casey, their three young sons, and friends regularly enjoy cookouts featuring shark steak grilled or broiled. The meat can be prepared as a large roast. Mr. Casey, entertaining a group of Italian scientists who had never tried sharkmeat, presented them with samples. The Italians added their own touches in a spicy sauce and pronounced the dish "magnifico," better, they said, than some other fishes they had eaten. All spokesmen agree that shark as a food item has certain advantages other than its palatability and high protein content: The flesh of the preferred species is pure white and, because the shark's skeletal structure is made of cartilage, not bone, cleaning and butchering of the boneless meat for the market is easily accomplished, and cooking is simplified.

Asked where a potential purchaser might buy shark products, Mr. Casey said, rather regretfully: "Probably he would have to visit a fishing dock and buy direct from a fisherman. Our food markets rarely stock sharkmeat."

Many fisheries experts, Casey and company included, believe it would be advantageous to American fishermen and consumers if a taste and market for shark could be developed in this country. "Sharks represent an almost virgin stock of fish present in inshore and offshore waters, and are relatively easy to catch, particularly on longlines," Mr. Casey said. "And it's quite conceivable that our modern technology could overcome the problems presented by the characteristic rapid deterioration and occasional high flavor of shark meat." He added that Russian food technologists recently completed intensive testing of many shark species toward the possibility of creating a new source of protein for their people and thus expanding Russian fisheries.

Sharks offer commercial products other than meat. Their livers are a source of oil and vitamin A; dried fins (worth $1.30 a pound) are in demand for the gourmet item, sharkfin soup; and shark skins (worth up to $25 each) are tanned to produce a fine tough leather. Shark teeth are sold as curios.

Casey pointed out that the expanding recreational fishery for shark is unique in certain respects: "There is absolutely no conflict between sport and commercial fisheries, because the shark species are presently so extremely underutilized that there is plenty for everybody. Consequently, though sport fisheries for shark are indeed increasing, they are a long way from conceivably presenting a threat to any commercial fishery."

He also said that it would be unlikely that even the most ardent conservationist would raise objections to a shark fishery, adding: "Many population dynamics experts believe that existing numbers of sharks must be disproportionately high compared to more desirable species that have been intensively fished for centuries."

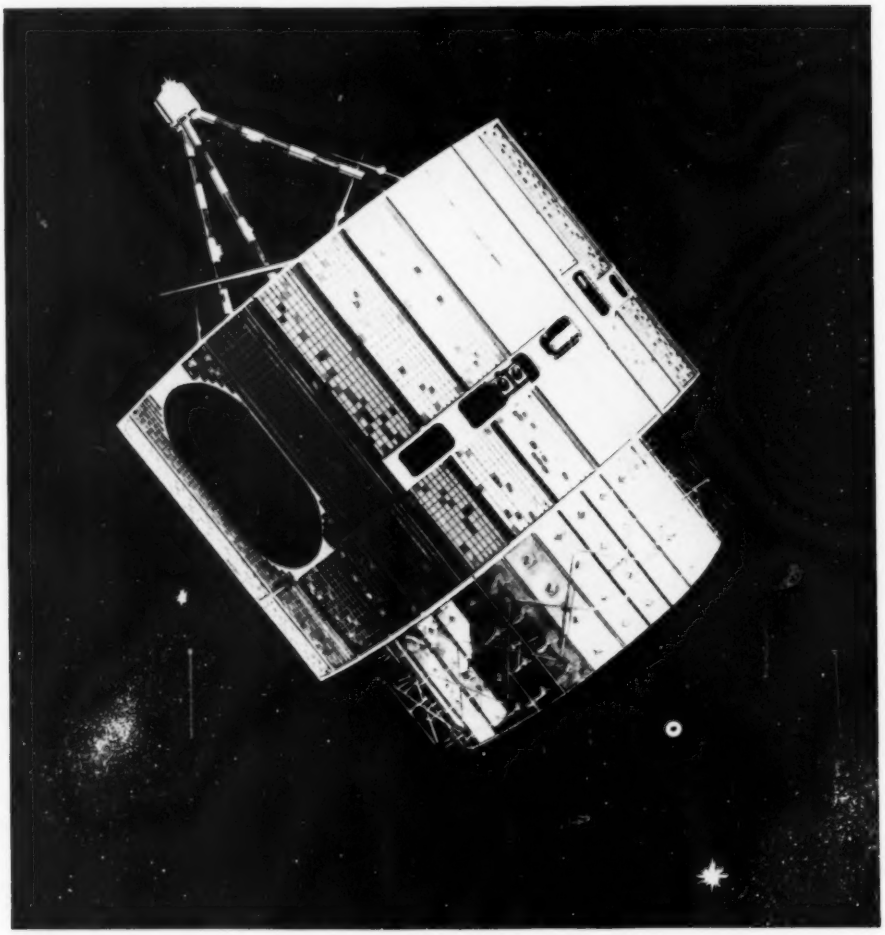
Even though shark catches have been high in certain periods and places, the effort has been uneven and unsustained. Some observers claim that particular commercial fisheries operate in such a way as to actually create a kind of aquaculture that results in higher than normal production of sharks. The concentrated Gulf of Mexico shrimp fishery, for instance, inadvertently nourishes a rich feeding ground for sharks by processing immense shrimp catches aboard vessels and discarding waste material into waters heavily populated by scavenging sharks.

The NMFS scientists involved in the shark investigation believe that their extensive studies could have additional known and unknown application to both the scientific and recreational communities. They point out that future "Man in the Sea" programs might very well have a need to know the locations of traditionally heavily infested shark grounds, and to help them avoid those areas in selecting sites for aquanauts and undersea habitats. Evergrowing numbers of big-game anglers might elect to turn their effort from the heavily exploited billfish and tuna to the more plentiful sharks, if they were confident of being able to locate productive fishing grounds. In the event that evidence was detected of an over-abundance of sharks or a geographical shift in a shark population, any seeming danger of shark attack to swimmers at seaside resorts might require population control measures or a warning system.

"We've learned a great deal about sharks in just ten years," said project leader Casey, "but we need to know much more to reach beyond the preliminary stage represented by the information now in our possession. We hope to keep adding members to the list of volunteer sport fishermen who have been so generous with time and effort. Only through their continued cooperation can we obtain the data needed to chart the movement of sharks through Atlantic waters and relate those movements to the biology and life history of other game species." □

GOES IS COMING and with it THE 18 MINUTE MIRACLE

BY ANN K. COOK



Spacecraft in the GOES system will provide images of one-fourth of the globe every half hour.

A welcome information explosion will burst on the scene with the launch this year of the first two satellites in the GOES system.

To Weather Service Forecast Offices, this explosion will bring detailed images of area clouds and storms every 30 minutes in daylight hours, and views of weather systems over one-fourth of the globe every half hour at night.

To River Forecast Centers, it will bring instantaneous readings on critical rainfall and river levels at remote locations.

To those who warn of space disturbances and communications disruptions, it will bring unprecedented data on conditions in the space environment.

GOES—for Geostationary Environmental Satellite—is the operational descendant of NASA's two experimental Applications Technology Satellites which clearly demonstrated that earth-synchronous spacecraft have great value in observing environmental conditions.

In 22,300-mile-high orbits over the Equator, a satellite traveling at about 6,800 miles per hour remains continuously above the same spot on earth and is thus termed geostationary, geosynchronous, or earth-synchronous. The hovering spacecraft has the same region always in view, and its sensors can watch the entire life cycles of short-lived storms that could form and die without ever being observed by polar-orbiting satellites.

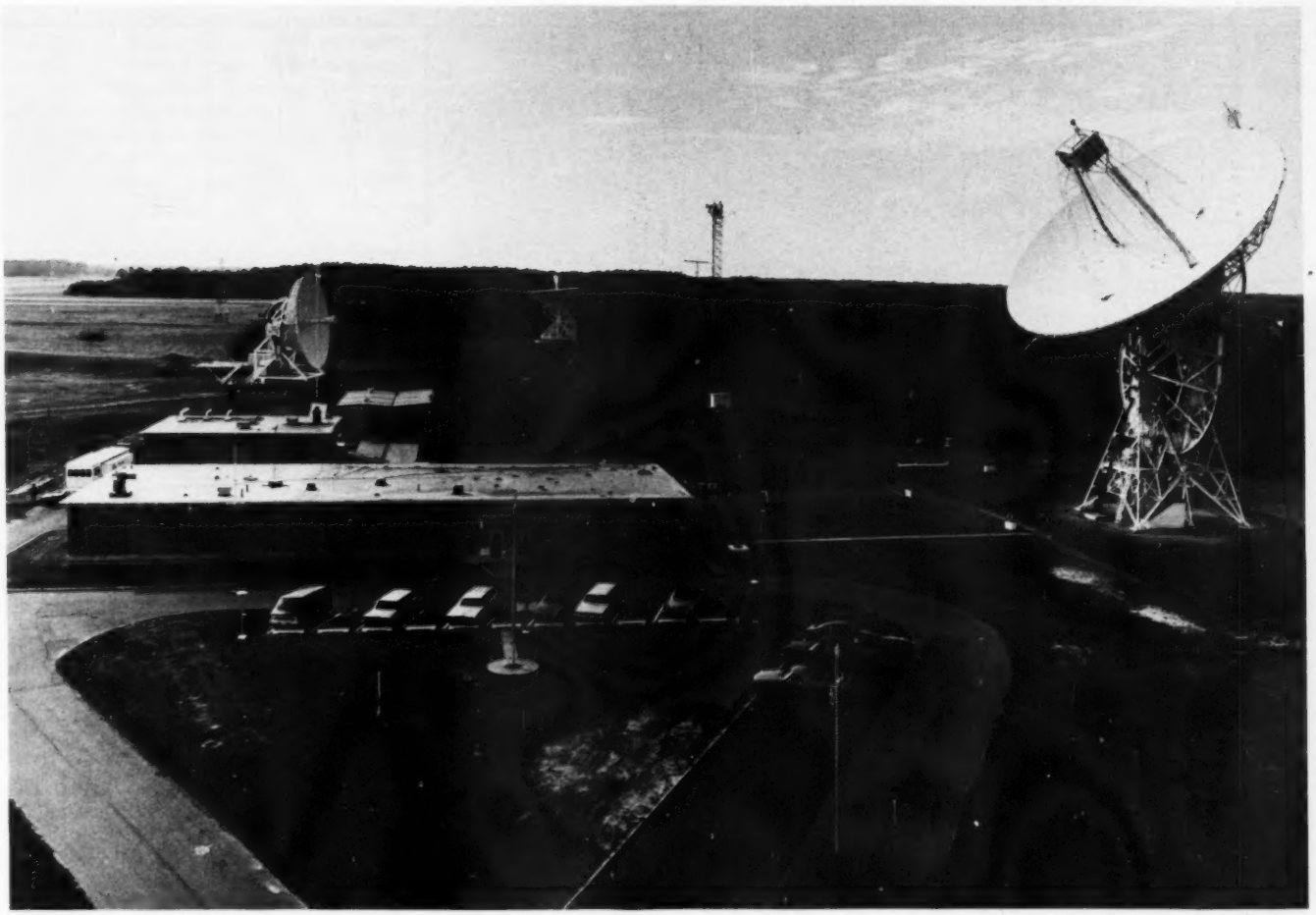
More than a decade ago, earth-synchronous environmental satellites became part of the plan for the National Operational Meteorological Satellite System, and in 1970 a contract was awarded for three such spacecraft—two for the National Aeronautics and Space Administration, to be called Synchronous Meteorological Satellites, and one for the National Oceanic and Atmospheric Administration, to be designated Geostationary Operational Environmental Satellite or GOES.

The two NASA prototypes are scheduled for launch from the Kennedy Space Center during the first half of 1974. They will be stationed at approximately 135 degrees west longitude and 70 degrees west longitude where they will see all of North and South America and the adjacent ocean areas. After checkout by NASA, the Synchronous Meteorological Satellites will be turned over to NOAA's National Environmental Satellite Service for operational use in the GOES system.

Because of its special capabilities, GOES represents much more than a single step forward in environmental observation. It is a revolutionary observing system for use in short-range forecasting and warning of weather, ocean, and solar hazards, providing nearly continuous, detailed observations and collecting timely observations of developing hazards from instruments in remote inaccessible areas.

In daylight, the nearly half-mile resolution images of cloud systems will give forecasters information on the evolution and and motion of middle-scale events that previously could be obtained only by radar. But GOES will provide images over oceans and remote regions where no radar exists, and will observe systems radar cannot see, such as fog, stratus, and non-precipitating clouds. The system also will provide improved information on the growth and movement of larger storms, including tropical and extratropical cyclones.

Day-and-night views of the earth's cloud cover and oceans will be obtained by the GOES Visible/Infrared Spin-Scan Radiometer (VISSR). As the satellite spins at 100 revolutions per minute, the VISSR's scanning mirror will face the earth for about one-twentieth of each complete 360-degree rotation, scanning from west to



The Wallops Island, Va., Command and Data Acquisition Station has two antennas for GOES and one (at right) for NOAA satellite operations.

east in eight identical visible channels and two redundant infrared channels. Immediately, the scan data will be transmitted in digital form to the Wallops Island, Va., Command and Data Acquisition station, operated by NOAA's National Environmental Satellite Service. While the spacecraft is completing its revolution, the mirror will move to the next southward step, and scan again when it is looking at the earth once more.

Within 18.2 minutes, the radiometer will accomplish the 1821 scan steps required to provide an image of nearly one quarter of the earth's surface. The resulting visible images, made only in daylight, will contain 14,568 lines and have a resolution of nearly ½-mile. Infrared images, acquired in darkness as well as in daylight, will have a total of 1821 lines, with 5-mile resolution.

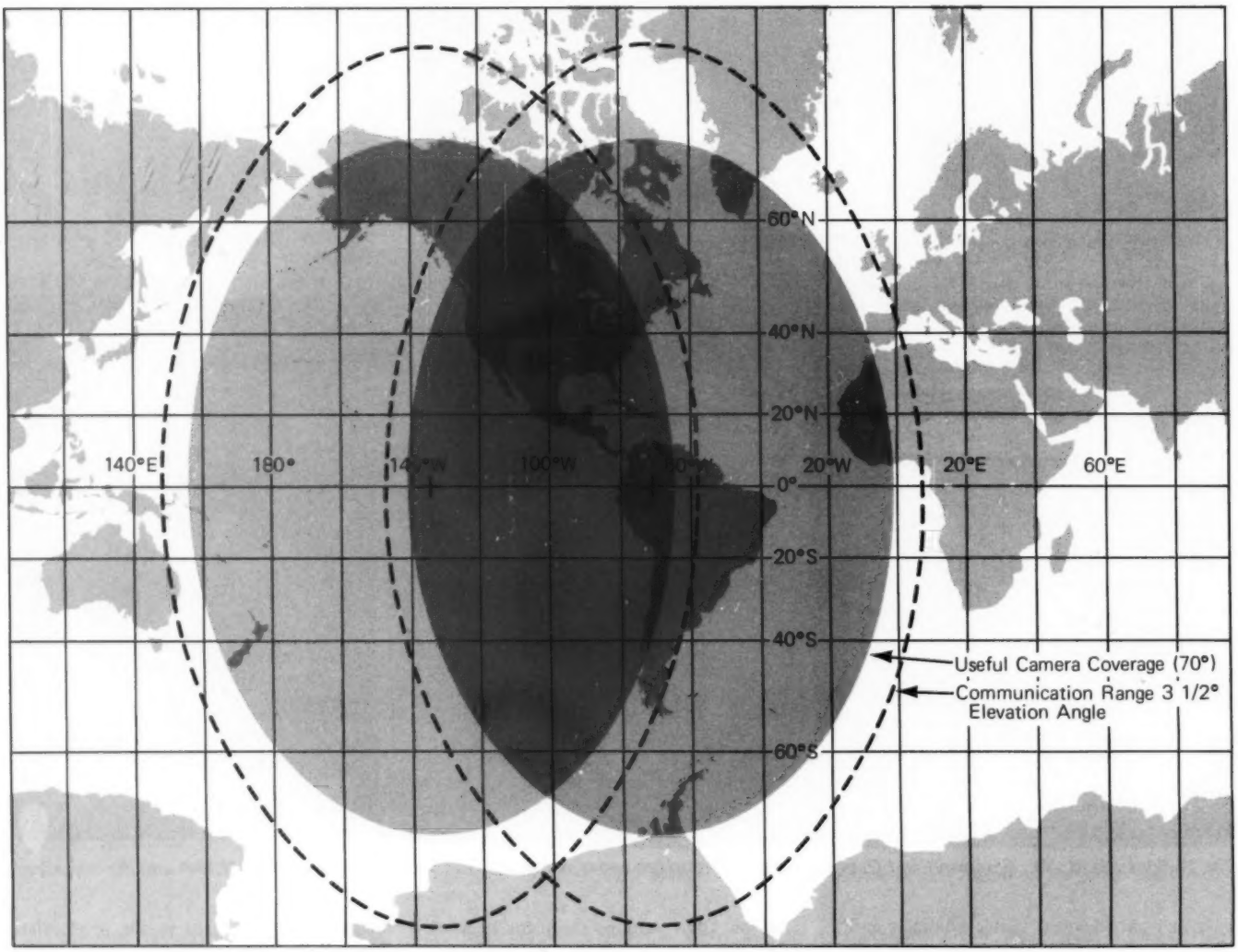
Allowing time for the scanning mirror to return to its starting point, and for correction of any "wobble" which may be caused by this retracting action, the Satellite Service plans to schedule GOES picture coverage at 30-minute intervals. The instrument can be commanded to scan smaller portions of the earth, providing more frequent picture coverage when and where it is needed.

At the CDA station, the eight lines of visible data acquired while the spacecraft looks earthward will be gridded automatically and the rate of data transmission reduced by specially designed equipment. As the satellite is completing its revolution and the VISSR is looking toward space, the "stretched" data signals will be retransmitted from the CDA station through the satellite to Suitland, Md., where they will be received by one of two 24-foot dish antennas atop National Environmental Satellite Service headquarters in Federal Office Building Number 4. The stretched visible data will be relayed by microwave link to the Satellite Service's Central Facility, a few miles away in the new World Weather Building. Thus, the Central Facility will have signals forming a complete image less than a second after the spacecraft has acquired it.

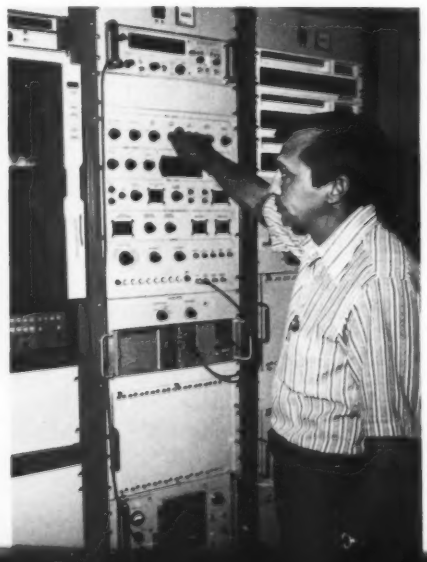
A bank of 18 electronic units called "sectorizers" has been installed in the Central Facility to extract desired portions from the total image and transmit them through telephone lines to Satellite Field Services Stations for Washington, D.C., Kansas City, Mo., Miami, Fla., and San Francisco, Calif. What a sectorizer does, in essence, is snip two pieces from each image and direct them to the appropriate field station. These "picture pieces" normally will come only from the Northern Hemisphere half of the total GOES image, which will be available at the Central Facility about nine minutes after each picture-taking sequence begins. Processing and transmitting the data will require another 17 minutes, so that the Satellite Field Services Stations will receive their sectors before the satellite begins the next image.

At one-half-mile resolution, a total of 12 sectors will cover the contiguous United States with some overlap. An additional sector will be prepared for transmission to the Weather Service at San Juan, Puerto Rico, through the Miami Field Services Station. Every half hour, the San Francisco Satellite Field Services Station will receive four sectors over the Pacific and the western United States; Kansas City, five for the mid-United States including the Gulf of Mexico; and Washington, D.C., three for the eastern United States.

Above and beyond this regular service, each Satellite Field Services Station except Miami will have one dedicated sectorizer in the Central Facility, from which they can request two additional Northern Hemisphere sectors every 30 minutes. Two dedi-



(above) Useful camera coverage (inner circle) and communications range (outer circle) of two GOES satellites at about 135 and 70 degrees West. (Below) James Norton of the Wallops staff checks GOES data-handling equipment.



cated sectorizers will serve the Miami station, so that images of areas north or south of the Equator can be provided for use in tropical storm forecasting and warning.

As the visible signals are received at the Satellite Field Services Stations, they will be routed to Weather Service Forecast Offices. Needed telephone lines and receiving equipment have been installed at some Forecast Offices; plans are to equip the remaining Forecast Offices in the 48 contiguous states during the next several years. Automatic photorecorders will enable each Satellite Field Services Station to display all sectors transmitted through it; the Weather Service Forecast Offices also will have photorecorders for sector display. Using these, meteorologists in both facilities can view the same image simultaneously, while discussing its interpretation.

Infrared data from the Visible/Infrared Spin Scan Radiometer will be acquired by the CDA station and sent by telephone lines directly to the Central Facility and to the Field Services Stations, in the form of a 7-inch, 5-mile resolution photo of the entire earth disk beneath the satellite. The infrared images will allow the watch on cloud and storm systems to continue through the nighttime hours. Direct transmision from the CDA station will ensure a steady flow of GOES image to the field, even in the event of a catastrophic failure at the Central Facility.

The Central Facility also will serve the Central Wind Extraction Unit of the Satellite Service's Data Processing and Analysis Division, providing full disk pictures and certain sector coverage every 30 minutes, and as many as 20 movie loops every 24 hours. Using both manual and computer techniques, the unit will trace cloud motions in successive GOES images to determine wind speeds and directions. The derived wind information will be used in the large-scale analyses and forecasts prepared by the Weather Service's National Meteorological Center.

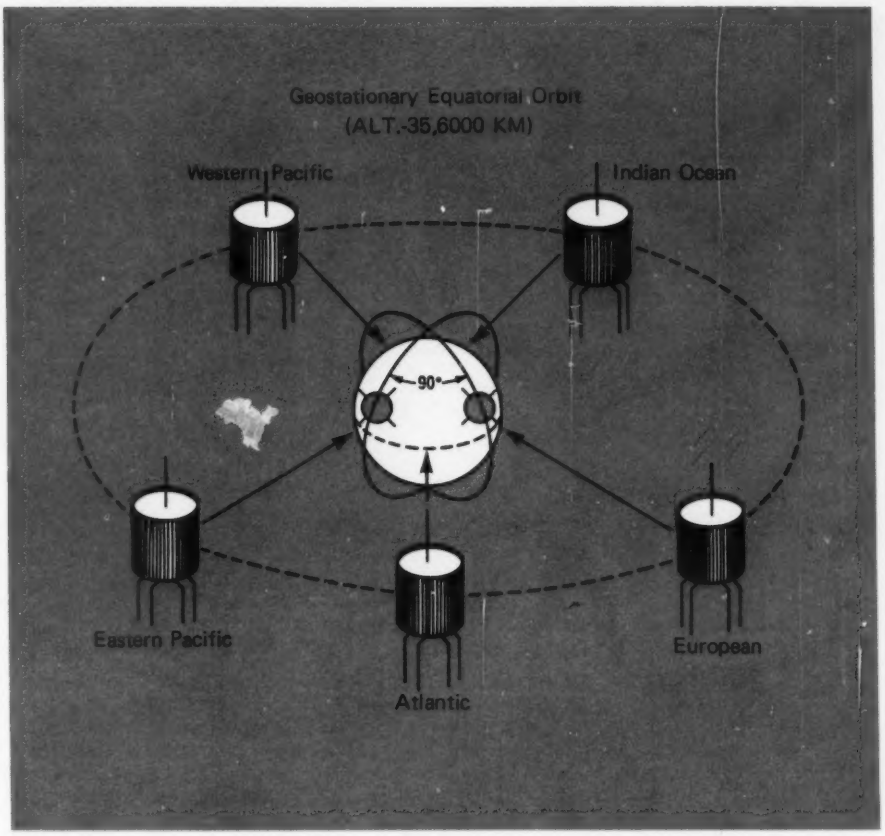
A complex device—called the Man-Machine Interactive Processing System—has been developed to aid the unit in extracting wind information from GOES images. The video system will display infrared data without any prior photoprocessing, showing cloud images on one screen and digits representing cloud temperatures

on another. Viewing the display, the unit's analysts will assign temperatures to clouds selected as "tracers," and these temperatures will be converted to heights (in terms of barometric pressure) by a computer which has access to NMC's global analysis.

The second observing system in the GOES satellite is the Space Environment Monitor. This sensor array will continuously measure changes in the geomagnetic field and the flow of protons, electrons, alpha particles, and solar x-rays in the vicinity of the satellite. The readings will be sent directly from the Command and Data Acquisition station to the Environmental Research Laboratory's Space Environment Forecast Center in Boulder, Colorado, significantly improving the Center's ability to forecast and warn of solar disturbances, disruptions of high-frequency communications, and potential dangers to manned space missions or supersonic flights.

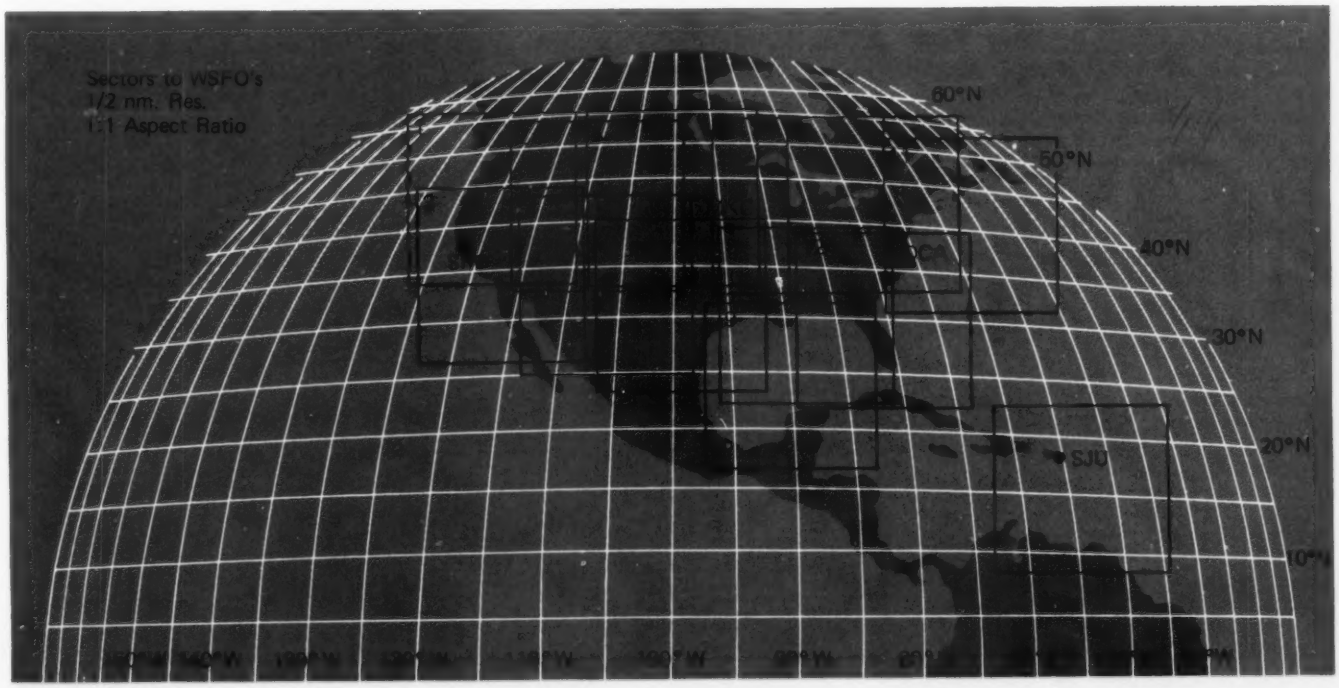
Although the low-orbiting spacecraft in the NOAA series monitor solar protons, they can do so only when they are over polar regions where the earth's magnetic field does not shield them from the particles. GOES has a significant advantage in that, from geosynchronous altitude, it can monitor solar effects continuously and transmit the data instantly to the ground.

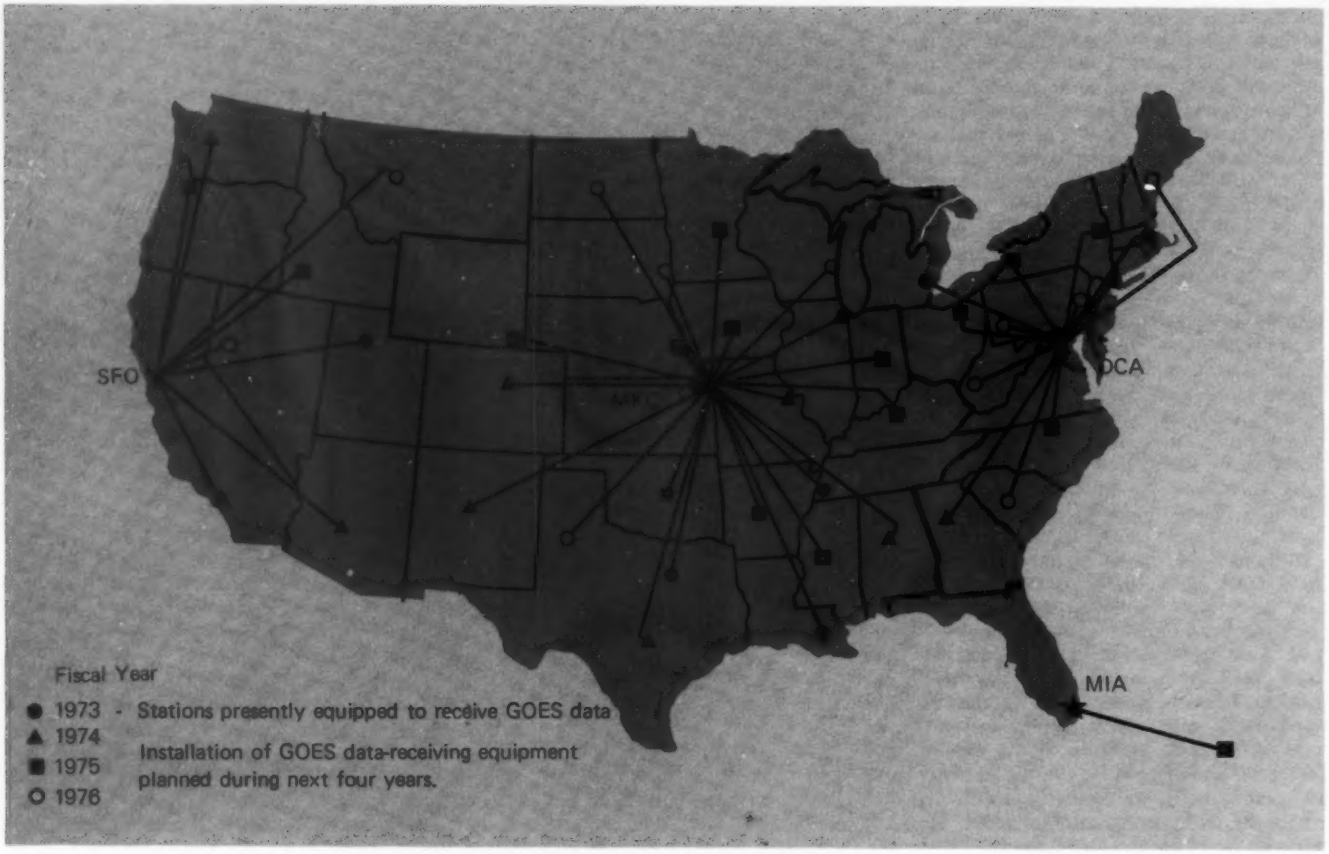
Data from the system's x-ray monitor will permit early warning of major solar events as well as estimates of their immediate effects on very-low-frequency, low-frequency, and high-frequency communications. A magnetometer will measure changes in the earth's magnetic field, the changes responsible for the variations in charged-particle motion that cause polar communications blackouts and radiation



(Above) Two GOES spacecraft, with three additional synchronous satellites planned by other nations, will keep continuous watch on all but the far polar regions of earth.

(Below) Approximate locations of GOES image sectors to be sent to the San Francisco, Kansas City, and Washington Satellite Field Services Stations and to the Weather Service at San Juan.





GOES images will be routed from the Satellite Field Services Stations to Weather Service Forecast Offices, providing them with detailed area images every 30 minutes in daylight hours and full disk images every half hour at night.

hazards to space and high-altitude flight.

One of the most significant advances brought about by the GOES system will be in data collection. By means of a transponder system, each spacecraft will be able to collect environmental observations from more than 10,000 remote sites on land or sea, every six hours. Remote observations planned or envisioned include weather reports from moving commercial and research vessels, tide measurements for the tsunami warning system, river and rainfall observations for preparing river and flood forecasts and warnings, ocean and weather data from tethered or free-floating buoys, observations tailored to the needs of the agricultural and fire-weather services, and weather reports from Caribbean and Pacific Islands, as well as from automatic observing stations.

Each observing platform used with GOES will be equipped with a radio set and an antenna, permitting reception of commands from and transmission of data to the satellite. Two types of platforms are planned. One type would report when interrogated and the other at set time intervals. Some, planned for future locations will broadcast spontaneously whenever a certain measurement threshold is reached; river gages, for example, may be preset to communicate with the satellite only when the water reaches a level that poses a flood threat. All platform data will be transponded through the satellite to the CDA station, transmitted from there to NESS by land line, and further distributed on existing teletypewriter or by computer link.

Initially, the number of platforms reporting through GOES will be small. One of the first major uses will be a network of river and rainfall stations installed by the National Weather Service's Office of Hydrology in the Columbia River Basin of the Pacific Northwest, an area with a long-established need for timely reports from remote locations.

At present, the National Weather Service's river and flood forecast and warning service depends on meteorological data and on a vast hydrologic reporting network of nearly 5000 river and rainfall stations. This hydrologic network is largely manned by private citizens who are not always readily available at night and on weekends. Most of their reports are relayed by telephone and thus subject to problems that become worse in flood emergencies—busy lines, service interruptions, and shortages of personnel to receive the messages. As a result, vital reports may take several hours to reach a River Forecast Center where the information is analyzed and forecasts prepared. Less than 15 percent of river and rainfall stations are telemetered so that the collection center can interrogate the instrument directly. Thus, use of the GOES data collection and relay capability can significantly increase the lead time of river and flood forecasts and warnings, saving lives and reducing economic losses. Some one thousand of the stations currently comprising the NWS river and flood forecast and warning service are expected to be equipped to send data through GOES during the 1970's.

In the Columbia River Basin project, data collected by GOES every six hours will be relayed to the NWS Portland, Oregon, River Forecast Center. In storm and flood situations, the River Forecast Center can request more frequent readouts. The Center will use the information in preparing flood warnings, river level, and water supply forecasts, and to assist reservoir and power-generation operations.

The GOES data collection capability is available to other agencies, as well as to NOAA. The Geological Survey, Corps of Engineers, and Soil Conservation Service, in cooperation with NOAA, are planning hydrologic networks; the Naval Research Laboratory will install a platform on Ascension Island to monitor fog; Stanford University expects to operate a system at Siple Station in the Antarctic to monitor geomagnetic data. NASA, in cooperation with the State of California, will test a platform for monitoring forest-fire danger by wind, air-temperature, and soil-moisture

measurements; ultimately this one test program could lead to the installation of 50 to 100 similar platforms in the state.

Like the earlier Applications Technology Satellites, GOES spacecraft will be equipped to relay cloud-cover pictures, centrally processed weather maps, and other facsimile data to receiving stations within line of sight. Because of power limitations, the weather facsimile (WEFAX) subsystem cannot operate while the satellite is transmitting images to the CDA station or relaying stretched image data from the CDA station to the Satellite Service. Therefore, when weather facsimile relays are scheduled, one or more imaging sequences would have to be omitted. Existing APT equipment will require modification—an S-band antenna and an S-band-to-VHF converter—to receive GOES facsimile transmissions.

To acquire, relay, process, disseminate, and use the huge volume of information the GOES system will generate, the Satellite Service has staffed and equipped several new facilities and expanded some previously existing ones.

The NESS Satellite Operations Control Center at Suitland has been enlarged to handle its increased workload. This center will originate all instructions to be given to the satellites—commands to start or stop earth scanning, to transmit facsimile data, to interrogate remote data-collection platforms, to read out housekeeping and solar data, to change spacecraft attitude, spin rate, or location. From Suitland the commands will be relayed by teletypewriter to the Wallops CDA station. In addition to managing daily operating schedules for satellites in the GOES and NOAA series, the Center—headed by Al Butera—will continue to monitor the "health" of all spacecraft systems.

Instructions prepared by the Satellite Operations Control Center will be forwarded to the satellites by the Wallops Island Command and Data Acquisition station. Initially established as one of two CDA stations for the polar-orbiting satellite series, the Wallops facility now becomes, in addition, the master CDA station for GOES operations. Its new manager is Lloyd Tourville, who headed the Gilmore Creek, Alaska, CDA station for a decade.

The Wallops staff has been doubled from 60 to 120 to handle the added work of round-the-clock GOES operation. A new addition to the building accommodates the complex web of electronics units and consoles for GOES. Outside, towering over the marshy coastal terrain, two 60-foot dish antennas have been erected, one to communicate with each GOES spacecraft.

In addition to relaying commands, the Wallops CDA station will acquire and stretch all visible data gathered by the GOES system and retransmit it through the satellites to Suitland. It will receive, process, and send satellite housekeeping data to SOCC; interrogate data collection platforms, receive the observations, and send them to Suitland; acquire and relay data from the Space Environment Monitor; transmit weather facsimile data to the satellite for retransmission to APT stations; receive and route infrared data to the NESS Central Facility and to the Satellite Field Services Stations.

Another function of the Wallops CDA station is to determine the exact location of the spacecraft, so that accurate latitude and longitude grids can be added to the stretched image signals. For trilateration and ranging, two remote automatic "slave" transponder units are required for each GOES satellite. The CDA station sends ranging signals through the satellite to the two slave units and to itself. Elapsed time for each signal's return is then used to pinpoint the satellite's location. Remote triangulation stations for the first GOES spacecraft have been installed at Santiago, Chile, and on Ascension Island. Additional stations will be established for the second satellite.

The Field Services Division, headed by W. John Hussey, was created within the Satellite Service's Office of Operations to furnish GOES information and services to NOAA units in the field. The Field Services Division includes the NESS Central Facility and the Satellite Field Services Stations.

The Central Facility, together with the Central Wind Extraction Unit, occupies an entire floor of the newly completed World Weather Building in Marlow Heights, Maryland. Its banks of electronic equipment, such as the image sectorizers, will be operated and maintained by contractor personnel. The Facility includes a modern photographic laboratory, which will process images and prepare film loops, photoenlargements, and other needed products.

Round-the-clock analysis and interpretation of GOES data for weather, ocean, and fisheries field operations will be provided by the four Satellite Field Services Stations—at Marlow Heights, Md., colocated with the Washington, D.C., Weather Service Forecast Office; in Kansas City, Mo., with the National Severe Storms Forecast Center, at Miami with the National Hurricane Center, and at San Francisco with the Weather Service Forecast Office.

Each Field Services Station will have a complement of nine meteorologists, allowing at least two per shift for 24-hour-a-day operation. Except at Kansas City, each will also have a staff oceanographer. Operation and maintenance of electronic equipment, and photographic services will be provided under contract. H. Ross LaPorte is the Station Manager at the Washington, D.C., facility; Edward W. Ferguson at Kansas City; Donald C. Gaby at Miami; and Jack D. Bottoms at San Francisco.

The stations will forward images and sectors to Weather Service Forecast Offices, and provide operational assistance in data interpretation to the Forecast Offices and other NOAA users. Film loops and enlarged images will be prepared for local use.

To assist the GARP Atlantic Tropical Experiment in the summer of 1974, a field services unit will be set up in the project's Operations Control Center at Dakar, Senegal, where GOES data will be received from the Central Facility by means of special lines. After the completion of GATE, the equipment will be moved to Honolulu, and a fifth Satellite Field Services Station established there.

The two Synchronous Meteorological Satellites soon to be launched for the GOES system will inaugurate an international constellation of spacecraft. The Soviet Union proposes to place a satellite in geostationary orbit over the Indian Ocean; Japan plans to station one over the western Pacific; and the European Space Research Organization expects to put another over the eastern Atlantic. Then, all but the far polar regions of the earth will be under a continuous environmental watch. □

Two 24-foot dish antennas atop NESS headquarters in Suitland, Md., will receive stretched data signals from GOES spacecraft.

With a little help from NOAA marketmen,

Guess What's Coming to Dinner?

BY JACK T. BRAWNER*

The demand for seafoods has changed dramatically during the past six years.

For 50 or more years, the U.S. commercial fishing industry was faced with inadequate market outlets for fishery products. Then, during the early 1960's, the demand for seafood began to rise, and since then, has accelerated. Markets are expanding at home and abroad for species such as squid, eels, and sablefish, little used in the past by U.S. consumers.

During the past six years, we have had more and more fish shortages—particularly of traditional species. During this period, annual per capita consumption has increased along with rapid price increases. For example, per capita consumption increased from 10.6 pounds in 1967 to 12.2 pounds in 1972. During this same period, the price paid the fisherman for fishery products (the ex-vessel value) increased from $438.3 million to $703.6 million.

What has caused this rapid increase in the demand for fishery products? Obviously, there is no single answer, but a combination of many factors—increased population, a general upgrading of the quality of fishery products, enhanced consumer awareness of the taste and nutritional values of seafoods, the development of a wide variety of new product forms, and increased purchasing power which has boosted demand for high cost seafoods such as shrimp, lobster, and scallops.

One important program that has increased U.S. demand for fishery products and enhanced the economic position of the commercial fishing industry in many areas of the country has been the marketing effort of the National Marine Fisheries Service, carried on cooperatively with the states and industry, and now with university fisheries and food science experts through Sea Grant.

Market development is a major component of the marketing program, and often involves demonstrating to key producers, distributors and buyers the feasibility of marketing underutilized species. The demonstration package might include information on sources of supplies, and on current market conditions, product samples, help in overcoming technological problems of processing, and information on potential markets. Means of disseminating information include both informal face-to-face contacts with industry and the distribution of reports on the feasibility of establishing new fisheries.

NMFS backs up these efforts by providing consumer educational support, through seafood consumer specialists such as our trained home economists and cooperating state home economists. Other important services are provided by personnel asigned to the NMFS Consumer Education Services Office, located in Chicago, who concentrate on developing unique and informative educational materials, and by the NOAA-NMFS film distribution program which lends strong support to the consumer education effort.

NMFS regional marketing coordinators are located at Seattle, Washington; Gloucester, Massachusetts; Terminal Island, California; and St. Petersburg, Florida. Examples in this article are drawn primarily from the latter region, which the author knows best, but could be found equally throughout the network.

Development of markets for underutilized species is the key to today's ongoing marketing program. For example, at least a dozen species of fish and shellfish now sought by U.S. fishermen are so abundant that appreciable increases in catch could be sustained. But the demand does not yet exist. Successful marketing efforts of these underutilized species will provide both a boost in supplies of fishery products, and additional opportunities for fishermen.

Overall, the NMFS marketing program earmarks considerable resources for consumer education to back up the development of markets for underutilized species. This benefits both the consumer, who gets a widening knowledge of choices of foods, and industry, which gets much-needed

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Bringing fish delicacies to public attention: above, Arleen Joyce of NMFS (left) on TV; below left, Florida home economist on New York City radio show; below right, Minnesota state marketman discusses Jonah crab sales potential with Green Giant company executive.

assistance in the developing and operating fishery markets.

The initial national marketing effort in the Southeast Region, in 1964, involved the development of a new fisheries publication "Florida Fish Recipes" and accompanying food photographs jointly financed by the Southeastern Fisheries Association, the Florida Department of Natural Resources, and NMFS. National coverage was received on Southern seafoods. As a result of the success of this initial effort, the commercial fishing industry in Florida convinced the Florida Legislature in 1965 to impose a special tax on industry and earmark these funds for fishery marketing. This provided State marketing money which the State used to qualify for marketing under Public Law 88–309. This enabled the State to expand its marketing budget from $47,000 in 1964 to $300,000 in 1965. The success of the Florida marketing program inspired officials in other states—Maine, Massachusetts, Maryland, North Carolina, and Texas—to initiate marketing programs. In Texas, the marketing program is financed also by an industry initiated state tax.

Since 1964, annual marketing staff conferences have been held to plan jointly and initiate marketing programs. Initially, these conferences included the marketing staffs of the State of Florida, the Southeast Region of the National Marine Fisheries Service, and key industry leaders. Later, the marketing staffs of the States of Texas, North Carolina, and Maryland were included. This past year, representatives from Sea Grant universities participated in the annual planning session.

The cooperation program received its first critical test in 1966. On what some fishing circles came to call "Black Friday", the relaxation of Friday meat abstinence rules for Roman Catholics caused a sharp decline in the demand for seafood. But, despite notable disruptions in some fishery markets, fishermen in the South Atlantic and Gulf received a record $151.8 million for their catch. And shrimp landings valued at $103 million marked the first year that the ex-vessel value of a single fishery reached $100 million. More to the point, the Gulf and South Atlantic accounted for $99 million of the total.

The marketing program in the southeast has been used for a variety of species. In the fall of 1965, at the request of industry, a special market development program was initiated for Spanish mackerel. Landings of 6.1 million pounds the previous year had been the lowest since 1954. Landings in 1965 reached 8.0 million pounds and climbed to a record 11.8 million pounds in 1968. Ex-vessel values during this period increased from $564,000 to $1.2 million. Of even more importance, fish filleting machines were introduced in the Southeast for the first time. These machines were developed specifically to fillet Spanish mackerel and they enabled industry to produce a larger volume in a shorter time, and at lower unit cost. The same firm (La Pine

NMFS marketing coordinator Roy Stevens meets with a delegation of Japanese trade representatives sampling underutilized fishery products.

Brothers) that developed the Spanish mackerel filleting machines later developed a rock shrimp splitting machine that is enabling industry to pursue development of this latent fishery resource.

The shrimp industry has experienced periodic and serious supply-demand imbalance problems. In 1964, a special market development effort was initiated for canned shrimp. Later in 1964, a similar program was undertaken for fresh and frozen shrimp and repeated in 1967. In all three instances, the programs were successful. And the "Shrimp Christmas Tree" promotions begun in 1964 were especially successful and have had much to do with shrimp now being used extensively during the Christmas and New Year holidays.

On three occasions, the blue crab industry also was faced with market gluts. On each occasion, intensive market development efforts were successful in alleviating these gluts and simultaneously broadening the market base for blue crab meat.

For many years, rock shrimp have been discarded at sea by shrimp fishermen. Because of its hard shell, there was no known way to "process the critter." Marketing personnel were instrumental in bringing together engineers and processors to solve the problem. Rock shrimp then were introduced to several restaurant chain executives and food chain merchandisers, and industry currently is pursuing the development of this latent fishery.

The first year's production in 1971 amounted to 347,000 pounds. Last year, 675,000 pounds were landed and production is expected to exceed this in 1973. There is promise that this will be a multi-million dollar fishery in a few years.

Cooperative efforts have been underway for about three years to develop outlets for both "pan dressed" gray trout and gray trout fillets. There now are five processors in North Carolina engaged in this operation. There were none three years ago. Average production of gray trout for the five-year period 1967-1971 amounted to 6.2 million pounds. Production in 1971 amounted to 11.2 million pounds, and in 1972, landings were 15.8 million pounds. Most of this production still is sold fresh, but more and more is being processed.

Marketing program direction in the Southeast is changing to meet changing needs of industry. In years past, major effort has been aimed at expanding demand for seafoods in general, and within this framework, solving specific problems of industry. However, because of the present U.S. and world food situation, today's major efforts are aimed at increasing the supply of seafoods. Many underutilized species and latent fishery resources exist in the South Atlantic and Gulf. The need for development of these resources has led to cooperative efforts by industry, Sea Grant, states, and the National Marine Fisheries Service in the following programs:

Spanish and king mackerel. To increase production in the traditional Florida fishery, expand the fishery in the northern Gulf, and develop a fishery in the western Gulf.

Rock shrimp. Continue to increase production of rock shrimp off the east coast of Florida, the upper west coast of Florida, and off Contoy, and to develop a rock shrimp fishery off the Texas coast.

Croaker. Increase croaker production in the northern Gulf, develop export markets for croaker Surimi (minced fish), expand markets for both fresh croaker and croaker fillets, and to assist industry to produce and sell croaker blocks.

Eels. Assist in the orderly development of an eel fishery to take advantage of enormous export markets for both adult eels and elvers.

Smoked fish. Develop a large smoked fish industry in the Southeast. A variety of underutilized species, e.g., mullet, Spanish and king mackerel, make excellent smoked fish products.

Export marketing. Many items not readily acceptable on the domestic market offer

NMFS marketing specialists throughout the nation help develop the potential of many fishery products. Canner prepares Dungeness crab for market (above left), and NMFS staff member discusses salmon production with plant manager (above). Another NMFS specialist demonstrates smoking of mullet in outdoor barbecue (lower left). Such activities give the housewife a variety of tasty choices (below).

potential for export. For example, as a result of sample shipments of mullet roe to France and Japan last year, substantial quantities are being ordered this year. One firm in France has ordered 50,000 pounds of roe at $1.60 per pound, and it is known that Japanese orders will be substantially greater. Other items having potential include eels, croaker, ladyfish, king mackerel, and Spanish mackerel.

Mullet. U.S. landings in 1972 amounted to 32 million pounds. The maximum sustainable yield is estimated to be 200 million pounds. Our goal is to increase mullet production in 1973 by 10 million pounds. Marketing efforts with this species illustrate the effectiveness of coordinated and cooperative efforts.

For example, food chain merchandisers and restaurant chain executives from Miami, Florida, to Boston, Massachusetts, are being contacted by marketing personnel of the States of Florida and North Carolina and the National Marine Fisheries Service. These personnel also are contacting food editors in 12 states. Florida, North Carolina, and NMFS home economists are making personal appearances on television to inform consumers about mullet.

The University of Florida is conducting technological research to solve mullet rancidity problems. Sea Grant funds are being used for this purpose.

The University of Georgia is using Sea Grant funds to develop better procedures for the smoking of mullet. Concurrently, the University of Georgia, the NMFS, and the Florida Department of Natural Resources personnel are working together in conducting consumer acceptance studies on smoked mullet.

Marketing personnel of the State of Texas, the NMFS, and Texas Sea Grant are working together conducting seafood merchandizing clinics for retail food chains. In addition, they are working with industry in Texas to develop the mullet fishery in that state.

State marketing personnel in Maryland are conducting smoked fish workshops in that area to create consumer demands for smoked fish.

To sum up, the basic premise underlying a coordinated and cooperative marketing program is that collective efforts can be many times as effective as individual efforts. Such an approach combines energies, talents, and human and financial resources. And experience to date proves that no one organization can provide all of the ingredients necessary for maximum effectiveness. The cooperative industry-states-Federal marketing program has been successful in enhancing the economic position of the commercial fishing industry in the Southeast. Currently, with rising food prices and scarcity of many food products, it is important that we more effectively utilize our latent fishery resources. Marketing can, and is, playing an important role in accomplishing this objective. □

global climate and man

BY CARL A. POSEY

Q.—As increasing carbon dioxide concentrations in the atmosphere intensify the "greenhouse effect," the earth's surface will heat up, the polar ice caps will melt, and sea levels will rise catastrophically.

(a) True.
(b) False.
(c) I don't know.

Q.—As the burning of fossil fuels and various natural sources continue to introduce aerosols (suspended particles) into the atmosphere, the sunlight reaching the earth's surface will be diminished, surface temperatures will drop, and another Ice Age will commence.

(a) True.
(b) False.
(c) I don't know.

Q.—The global atmosphere is becoming increasingly and irreversibly contaminated by man-generated pollutants.

(a) True.
(b) False.
(c) I don't know.

A decade or so ago, the answers to these apparently simple questions would have been a confident "True!"—the effects, allowing for some personal choice between melting ice caps and another ice age, were as obvious as the smoke from industrial chimneys. Or were they? In fact, these, and a host of other, similar questions, would have been best answered with a conservative "I don't know." That is still the best answer today. As with everything in the environment, the questions go farther than they seem to.

And yet, answered they must be, for our final, full responses to them will do much to shape life and life styles on this planetary garden. Thus far, these responses have varied widely, from the environmental live-and-let-live of two decades ago to the activism of today. Since the International Geophysical Year (1957–1958), the clearest consensus among scientists has been that there remain major uncertainties. We simply do not know where we have been on the large, many-centuried curves of climatic change, or where we are going, or what hand our civilization has had, or will have in shaping these changes.

Like May flies studying an elephant, then, scientists began to look more closely at global climate, the combination of weather and sun and man and who-knew-what that is as old, and as young, as the planet itself. Gradually, the technology of measurement has permitted the accumulation of good data, and the identification of the first faint indications of climatic trends. And the investigation itself has been given form as NOAA's Geophysical Monitoring for Climatic Change (GMCC) program, man's first truly systematic effort to establish climatic benchmarks from which to reckon the minuscule year-to-year deviations of long-term change.

This program, managed by the Environmental Research Laboratories' Air Resources Laboratories, set out to establish a small, widely separated network of observatories equipped to measure precisely those atmospheric properties which appeared to be critically linked to long-term climatic change. The network, beginning with an existing station at Mauna Loa, Hawaii, would eventually include six observatories, each located to provide data from "clean" patches of the global atmosphere, over a large enough area to make the samples globally representative.

Thus, the GMCC program has placed an observatory above the Arctic Circle, in the Antarctic, and in the South Pacific Ocean area as well as in Hawaii. Plans call for two additional programs—in the Atlantic, beyond the industrial pollutant plume of the American east coast, and somewhere along our northwest coast.

"In planning the GMCC network," explains Donald H. Pack, who directs the program for the Air Resources Laboratories, "it was tempting to measure just about *everything*—sources, sinks, and transport rates of pollutants, relationships to industrial pollution and to biological effects, and on and on. But we understood that a program of reasonable size, with the amount of resources we had available for it, would have to be designed with an eye to yield. Consequently, we selected certain aspects that appeared to exert influence on regional and global climates, and that could be measured with adequate precision in 'clean' air."

Accordingly, each GMCC observatory would measure weather elements (temperature, humidity, precipitation, pressure, surface winds), whole-sky and direct solar radiation (over several important spectral intervals, including ultraviolet), atmospheric carbon dioxide concentrations, total and surface atmospheric ozone, atmospheric turbidity (clarity), various types of aerosols and two culture-linked gases, carbon monoxide and Freon-11. To these measurements would be added a greatly improved, compact data system built around a minicomputer, to handle the typical observatory's three million signals per day. In addition, each observatory would perform the measurements for other organizations that are a kind of geophysical tradition.

"What was required," Pack says, "was a more precise view of atmospheric constituents and how they change over periods of months, years, and decades. People have qualitatively observed such things as temperature, winds, and rainfall since prehistoric times, and quantitative variations have been gauged against a mean climatology over the last few hundred years. Our monitoring effort changes that focus to a benchmark climatology of atmospheric composition where we are concerned with millionths and billionths instead of tenths and hundredths."

Such traditions as there are in this new climatology were born at Mauna Loa Observatory, the keystone and in some respects the prototype for GMCC stations. Established on the Hawaiian volcano's ashy flank in 1951, the observatory has provided an ideal classroom for scientists to learn how to measure the quantities involved in studies of climatic change. At an elevation of 11,200 feet above sea level, the observatory site pokes up into a pristine atmosphere, usually separated from surface weather by the tradewind inversion, which inhibits vertical mixing, and by a nighttime flow of cold air down the mountain flanks. There is almost nothing upwind of Manua Loa except Asia, and nothing for two thousand miles on the downwind side.

Mauna Loa Observatory is currently unique. From the seven-building complex and its lava field surroundings, instruments measure much of what is measurable in the atmosphere. The usual climatological measurements of temperature, humidity, precipitation, atmospheric pressure, and surface winds are made with standard Weather Service instruments.

Whole-sky solar radiation has been measured at Mauna Loa observatory since 1957, using Eppley bulb type pyranometers. Direct sun radiation has been measured with Eppley sun-following pyrheliometers.

This solar radiation system has been supplemented by a new and expanded one, which has digital data and magnetic-tape storage, and includes: a 13-channel radiometer (pyrheliometer) with two channels for total irradiance, eight narrow-band filter channels, and three broad-band filter channels; four precision spectral pyranometers to match the total-irradiance and three broad-band filter channels; an ultraviolet sun-and-sky photometer; and an Angstrom-type electrical compensation pyrheliometer.

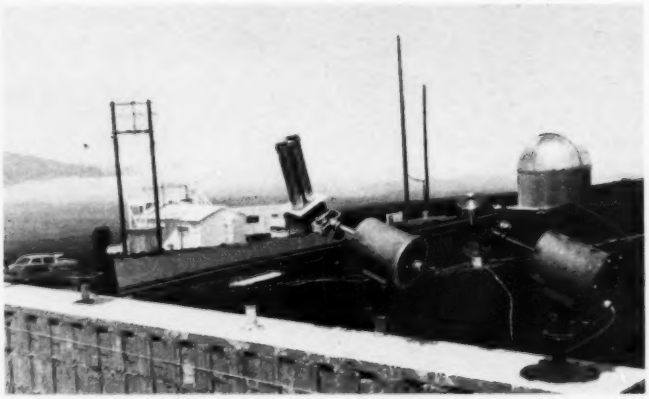
Atmospheric carbon dioxide concentration measurements are made with an infrared gas analyzer system developed for

Atmospheric extremes include Hawaii's Mauna Loa, virtually unaffected by man-made pollution (above) and the Nation's west coast seen through a blanket of dirty air (left). NOAA researchers like Donald H. Pack (at right with a sun photometer) are establishing sites for long-term climatological measurements.

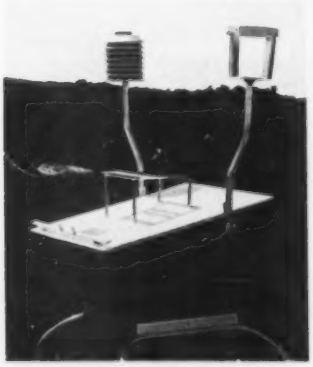
NOAA's Mauna Loa Observatory perches high on the clinker-choked slopes of that Hawaiian landmark.

A spore trap with an impactor may provide clues to air current flow.

A pyranometer provides whole-sky solar radiation measurements.



Sun-following pyrheliometers make direct measurements of solar radiation reaching the earth.



Trap samples air for sulfur, nitrous oxides, and aerosol mass.

Peering from its protective dome, a lidar system (a form of optical radar) detects particulate matter in the air.

ERL researcher Austin Hogan operates a Pollack aerosol counter at Mauna Loa.

The Offenders

Carbon dioxide (CO^2). A heavy, colorless gas representing about 0.033 percent by volume of dry air. More than 99 percent of terrestrial carbon dioxide is held in the oceans, but this oceanic reservoir and how it interacts with the atmosphere is still poorly understood. Carbon dioxide produces a greenhouse effect on incoming solar radiation, admitting wavelengths in the visible range, but tending to block wavelengths in the emitted infrared range, thus holding in solar heat. Increases in the atmosperic concentrations of carbon dioxide are presumed to be caused primarily by burning of fossil fuels.

Carbon monoxide (CO). A combustion product that exists in concentrations of about a part per 10 million in clean air. Its natural role, its sources and sinks, and its biological effects are uncertain, and the monitoring of it aims mainly at determining its fate once introduced into the atmosphere.

Sulfur dioxide (SO^2). Concentrations of this gas run as low as two parts per 10 billion at global background levels. Shortlived as an atmospheric constituent, scientific interest in it is mainly concerned with determining its influence on cloud physics through interactions with other constituents, especially aerosols.

Nitrogen oxides (NO_x). A family of pollutants of particular importance that includes nitrous oxide (N), nitric oxide (NO), and nitrogen dioxide (NO). Nitrous oxide is a long-lived, atmospheric constituent and not a significant industrial pollutant. Nitric oxide is a combustion product, especially high-temperature combustion, and is rapidly oxidized in the atmosphere by reacting with ozone (O^3) to form nitrogen dioxide (NO^2). The latter may be important for its role in absorbing solar radiation in the visible wavelengths, especially in urban areas, where it may reduce sunlight. Because both nitric oxide and nitrogen dioxide are highly reactive, vertical transport into the stratosphere is not considered a problem.

Ozone (O^3). This highly reactive gas exists in the troposphere in concentrations of about one to three parts per hundred million, an amount that appears to represent equilibrium between creation by photochemical interactions in the stratosphere and chemical destruction at the surface. In smog conditions, ozone concentrations may be as high as five parts in 10 million, making it a significant pollutant in some areas. Possibly more important, the stratospheric ozone layer absorbs hazardous ultraviolet solar radiation, and there is concern that the introduction of large quantities of such ozone-destroying compounds as nitric oxide into the stratosphere would weaken this shield.

Freon 11 (CCl^3F). This inert gas has a long lifetime in the atmosphere, and its main sources are in the northern hemisphere—principally the use of spray dispensers, which are charged with compressed Freon 11. Although it does not constitute a major pollutant at this time, Freon 11 has promise as a tracer of the atmospheric transport processes.

Aerosols. These are microscopic solid particles suspended in the atmosphere, including volcanic and wind-raised dust, and the various nuclei which provide condensation or freezing "platforms" for water in the atmosphere. Electrical conductivity measurements have indicated that, aside from areas downwind of the major industrialized continents, natural aerosol levels near the surface have remained fairly constant through the last few decades. Not much is known of stratospheric concentrations. Investigations here seek to understand the sources of atmospheric aerosols, how they are related to various photochemical interactions between gases, and what their role is in causing regional and global climatic change.

Mauna Loa by Dr. C. D. Keeling of Scripps Institution of Oceanography. Data are recorded on strip charts for manual evaluation, and on magnetic tape for computer evaluation. Besides acting as a clearinghouse for data evaluation and publication, Scripps also provides the standard concentration reference gases required for quantitative determinations of atmospheric carbon dioxide content and the small annual change—about one part per million on a base level near 325 parts per million.

Atmospheric total ozone is measured with a Dobson spectrophotometer, and surface ozone by an instrument employing an electrochemical concentration cell. Both types of measurement are highly sensitive, yielding measurement errors of only a few percent at the extremely low concentrations of ozone—about 0.5 parts per million for total ozone and 0.03 part per million for surface ozone.

Turbidity in the atmosphere is measured with simple two-channel sun photometers on cloud-free days. This information contributes to a global program of such observations conducted by the Environmental Protection Agency.

Atmospheric aerosols are monitored at various scales by Mauna Loa instruments. Aitken nuclei—the atmospheric nuclei that condense water vapor at 300 percent supersaturation—have been observed for many years with a manually operated Gardner counter. This instrument has been supplemented by a continuous-recording Aitken nuclei monitor and a multiwavelength integrating nephelometer which measures the atmospheric light-scattering coefficient. Freezing nuclei are monitored in cooperation with the High Altitude Observatory of the National Center for Atmospheric Research.

In addition, several other agencies operate measurement programs at the observatory. These include high-volume sampling of beta- and gamma-emitting particulates (Atomic Energy Commission); high-volume particulate sampling for total aerosol mass (Environmental Protection Agency); gas sampling for sulfur dioxide, oxides of nitrogen, and total oxidant analysis (Environmental Protection Agency); measurements of light scattered by electrons in the solar corona, using a solar coronometer (National Center for Atmospheric Research); and gas sampling for tritium in the form of HT ("heavy hydrogen" molecules, in which one hydrogen atom has been replaced by a tritium atom) and its "heavier water" form, HTO (University of Miami and Atomic Energy Commission). Under a cooperative arrangement, Mauna Loa Observatory also operates an advanced gas sampling system for the National Center for Atmospheric Research. This measures sulfur dioxide, nitrogen oxides, carbon monoxide, freons, and other gases, adding much new data to the baseline monitoring program.

A lidar system—lidar is the laser equivalent of radar—developed for Mauna Loa by the Atmospheric Physics and Chemistry Laboratory is used to sound the atmosphere for aerosols. Such systems permit investigators to identify the tropospheric and stratospheric inventories of these minute suspended solids, and advanced systems will eventually permit remote identification of aerosol composition and other properties.

Research activities at Mauna Loa supplement the GMCC monitoring. These seek to determine whether other properties—for example, chemical composition of bulk and individual aerosol particles, detectability of background concentrations of gases like sulfur dioxide, carbon monoxide, and nitrogen oxides, aerosol size distributions—of atmospheric constituents can be monitored, and whether the monitoring station can discriminate between man-generated (or anthropogenic) and natural materials.

The other "old-timer" in the network, at the South Pole is operated by NOAA in

cooperation with the National Science Foundation. A comparatively small amount of GMCC-type monitoring has been carried out there in the past, mainly to measure total ozone, surface ozone, and ozone vertical distributions. This year NOAA has begun an expansion of the South Pole operation. A minicomputer-based data system links all the sensors, and the scope of measurements has been significantly expanded, especially in continuous measurements of carbon dioxide and Aitken nuclei.

"This year we have a dual surface ozone measuring system along with the Dobson spectrophotometer total ozone measurements," reports Walter D. Komhyr, who leads the Air Resources Laboratories' Techniques and Standards Group and who developed some of the instrumentation used in the GMCC program. "In solar radiation we'll be measuring global (total hemispheric sky and sun radiation) as well as radiation in three broad wavelength bands—ultraviolet, visible, and near-infrared. Eventually, we plan some fine-line work. Aitken nuclei concentrations will be monitored with a Gardner counter and several other aerosol-sensing instruments. We will be measuring carbon dioxide with a continuous infrared analyzer as well as obtaining flask samples of carbon dioxide, and hope to add carbon monoxide sampling this year."

The Antarctic observatory is located about 2,000 feet upwind of the South Pole station main camp to ensure isolation from local pollution. The recorders are some 25 feet beneath the snow surface, sheltered beneath a metal arch about 19 feet in radius. A rather elaborate system of cane-shaped pipes was developed by Komhyr to get air samples—without contamination or destruction of gases and aerosols—from about 15 feet above the snow surface to instruments in the GMCC "cave."

Of the four remaining GMCC stations, two are operating and two are planned. Working with the Navy's Arctic Research Program Office, an observatory has been constructed at Point Barrow, which looks northward from arctic Alaska into the Beaufort Sea. During 1973 measurements began of multi-channel solar radiation, ozone, carbon dioxide, Aitken nuclei, and turbidity. In addition, the Barrow observer operates radiometer systems for the Smithsonian Radiation Biology Laboratory under a mutually beneficial, cooperative effort.

A fourth observatory is being established at Cape Matatula, Tutuila Island, in American Samoa, with the assistance and support of the population and government of the South Pacific territory. Selected by the National Geographic Society at the Air Resources Laboratories' request, the Cape Matatula station promises to be a source of unique data for this sparsely settled, industry-free corner of the southern hemisphere. A preliminary sampling program was begun here in June 1973, measuring turbidity, ozone, carbon dioxide, Aitken nuclei, and precipitation chemistry; an advanced gas analyzer like the one at Mauna Loa is being operated in conjunction with the National Center for Atmospheric Research.

To complete the NOAA plan for baseline measurements, two additional observatories are planned. One desired location is on the Pacific coast of the United States. An intensive site survey was begun in May 1973, to identify a suitable, pollution-free site. A sixth location is needed to compare trace contaminant levels representing "clean" Atlantic air with the airflow from the United States. The one location that seems to meet this objective is Bermuda, and the laboratories have undertaken a cooperative effort with the University of Rhode Island to obtain preliminary data which will indicate whether formal negotiations for an observatory should be undertaken.

"One of the things these stations have in common is that they all take advantage of their physical situation," Pack says. "We learned at Mauna Loa that ingenuity in employing local climatology can enable us to measure representative statistics on clean air concentrations, without making our observatories impossibly remote. In the case of Mauna Loa, the downslope wind and tradewind inversion work for us. At Barrow, the prevailing easterly winds and location of the observatory upwind of local installations perform a similar function. In American Samoa, although the island of Tutuila has a population of 26,000 and has an operating jetport, the position of Cape Matatula and the prevailing easterly tradewinds minimize local contamination. Except for small islands more than one hundred miles to the east, the Samoa observatory is exposed to winds with an essentially uninterrupted fetch of 4,000 miles over open ocean.

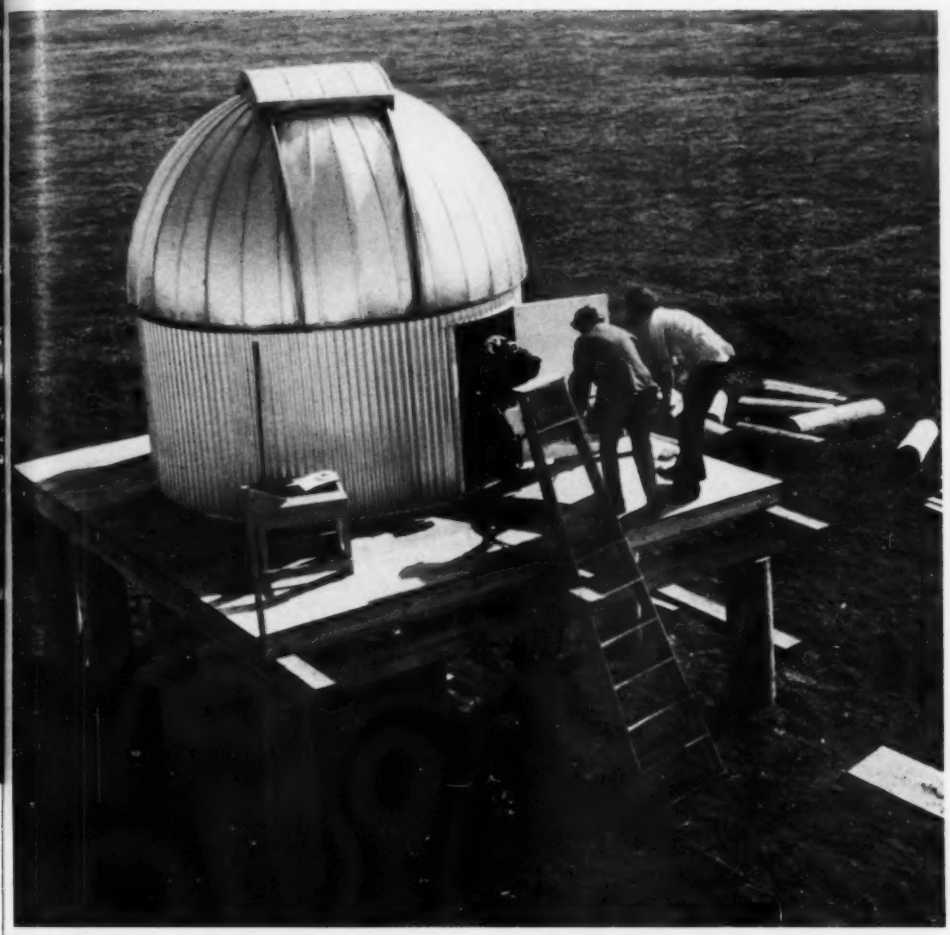
"Another common feature," he adds, "is that we are staffing the observatories with relatively small staffs, and providing quality control and instrumentation backup from headquarters and from Komhyr's group in Boulder. Fortunately, the instruments available today let us keep the number of observers to a minimum."

It may also be a common feature of the GMCC observatories that their early information will raise more questions than it answers.

For example, data collected at Mauna Loa and South Pole indicate an increase in atmospheric carbon dioxide at an average rate of about one part per million—about three-tenths of one percent—per year. However, this increase varies irregularly with time, for reasons not yet understood. It may be that variations in industrial growth, changes in vegetative use of carbon dioxide, or relatively small changes in the ocean temperature (warmer water holds less carbon dioxide) have caused the variability. The purpose of the network is to isolate causes of these changes.

Again, there has been an observed average increase in ozone over North America and other parts of the world during the past 10 years of about five percent. Why? Ozone is manufactured photochemically in the high upper atmosphere over the tropics, flows

The search for "clean" climatic observation sites has lead to the sun-dappled jungles of American Samoa (above), the barren tundra near Barrow, Alaska (right), and the bleak Antarctic ice at the South Pole (below).



northward at high levels, descends to the lower atmosphere near the poles, and moves southward again. Some scientists believe the observed increase was caused by warmer Pacific Ocean waters, which changed normal weather patterns so that more polar air—and so more ozone—was drawn southward. Others see the increase as only a return to natural levels following ozone destruction by injection of other materials into the stratosphere (for example, by volcanic activity). Some see a link with solar activity. But the data record is too short to permit a firm explanation.

According to Walter Komhyr, even things like where we are with respect to the next Ice Age remain unanswered. "Geological records indicate that past climate has varied cyclically over time, with glacial periods about 120,000 years long, and the warm intervals of the interglacial periods lasting about 12,000 years. We may have just hit our peak warming in this interlude; or we may have already passed the peak and are on our way to a new Ice Age.

"The logical question is, why hasn't man been studying these changes since ancient times—or, for that matter, since the turn of the century? Well, many of the things we are monitoring in this program have not been measurable very long. Some of the minor atmospheric gases we measure, for example, exist in concentrations of less than one part per million. Others must be measured accurately to within a few tenths of a percent error. Instruments for making such precise measurements have not existed in the past.

"Instruments for surface ozone measurements are still under development. Carbon dioxide monitoring instruments of the necessary sensitivity began arriving only in the early 1960's. Aerosol monitors are still being refined. Ultraviolet radiation measurements are even now very difficult to make. I don't like to say that our work is rudimentary, because we are working up to the thresholds of these kinds of measurement. But we are clearly just beginning. It is a new science."

For the future, the GMCC scientists hope to expand the number of elements measured, possibly through applications of the remote sensing technology becoming available from researchers in NOAA and other organizations. They also expect to add an oceanic component where the observatory location permits, measuring the partial pressure of carbon dioxide, carbon monoxide, and methane of surface ocean water along with such conventional things as temperature and salinity.

"Although we believe this is a vital program," Pack notes, "we understand that one national effort will not do the whole job alone. At the United Nations Conference on the Human Environment, the need for a multinational monitoring program was explicjtly recognized, and the climatic change monitoring programs of some nations are already well advanced. We hope now to begin working with those scientists to ensure that, among us, we can provide a truly global picture of the atmosphere." □

Tsunami! The great sea wave froths and churns into Hawaii's Kalihiwai Bay.

KILLER FROM THE BOTTOM OF THE SEA

The National Weather Service's newest disaster warning assignment is the tsunami

BY EDWIN P. WEIGEL

On September 16, 1973, the National Weather Service accepted responsibility for the U.S. Tsunami Warning System. In doing so, it took on the job of alerting coastal populations to a type of natural disaster that is among the most complex, catastrophic and misunderstood on earth.

Tsunamis are ocean waves generated by underwater disturbances in the earth's crust—usually earthquakes but sometimes submarine volcanic eruptions. The waves speed silently across the open sea at up to 600 miles an hour and sometimes wreak havoc on coastal areas thousands of miles away. They are also called seismic sea waves, because of their earthquake origin, and—erroneously—tidal waves. Tides have nothing to do with them.

Tsunamis are rare, fortunately, because they have been responsible for some of the worst disasters in history. One of the most devastating was the tsunami caused by the eruption and explosion of the volcanic island Krakatoa in 1883, which sent 100-foot waves crashing into Java and Sumatra, drowning 36,500 persons. Another was a tsunami which struck Japan in 1896 with 100-foot waves that killed 27,000 people. The most destructive in recent history was the Chilean tsunami of May 1960, which killed 1,000 people in Chile, Hawaii, the Philippines, Okinawa and Japan. Most damaging in the U.S. was the tsunami generated by the Alaskan earthquake of March 28, 1964. It killed 110 people and caused 104 million dollars' damage in Alaska, California, Hawaii, Oregon and Washington.

The present warning service for these killer waves was begun in 1948 as a result of a disastrous tsunami which inundated Hilo, Hawaii, two years earlier, killing 159 people. That tsunami was caused by an earthquake on the sea bottom near the Aleutian Islands, more than 2,000 miles away.

Briefly stated, the warning system is based on, first, the detection and pinpointing of an earthquake big enough and in the right place to cause a tsunami and, second, the identification by tide gages of ocean waves generated by that earthquake. A tsunami watch is issued when the proper-category earthquake is detected. A tsunami warning is issued when the presence of seismic sea waves is confirmed. This one-two approach is the same procedure as NOAA uses for hurricanes and tornadoes—first an alert to *possible* danger, then a warning of *actual* danger. Included in the warning are quite precise forecasts of arrival times for the first wave of the tsunami at populated points in and around the Pacific basin.

Only the Pacific has or needs such a warning system. Tsunamis that travel long distances are extremely rare in the Atlantic or other large ocean areas. The only really

damaging tsunami on record to cross the Atlantic followed the notorious Lisbon, Portugal, earthquake of 1775. Waves are said to have persisted for a week and to have occurred as far away as the Caribbean islands.

The Pacific is the arena of the tsunami and Japan is by far the most frequent victim, which accounts in part for our adoption of a Japanese word as the international term to describe this killer. Tsunami means "harbor wave." Japan has been scoured by devastating tsunamis at least 15 times in the past three centuries. Area of the U.S. hit most often is Hawaii, where tsunamis of varying severity occurred in 1946, '52, '57, '60, and '64.

The present tsunami warning system, headquartered in Honolulu, was begun by the U.S. Coast & Geodetic Survey (now NOAA's National Ocean Survey) in 1948. It remained under the supervision of that agency until 1971, when its management was transferred along with NOAA's earthquake program, also under the National Ocean Survey, to the NOAA Environmental Research Laboratories. (This move was one of several to concentrate NOAA's research management in a single agency; the warning system went along with that shift because tsunamis are too rare to justify a full-time 24-hour guard for them alone. Scientists did double duty as warners and researchers.)

Then, in the latest of a series of Government-wide efforts to restructure environmental affairs, the tsunami-warning service was transferred to the National Weather Service. Here it will be handled by the same team that spreads alarms for other fast-paced environmental hazards such as tornadoes, flash floods, and hurricanes—but not earthquakes. NOAA's earthquake research and information service has been shifted to the Interior Department's U.S. Geological Survey as part of a Federal effort to consolidate matters pertaining to the solid earth in that agency.

So it seems fitting that along with this reshuffling there should be a restatement of the nature of the killer waves called tsunamis, so that NOAA personnel will have a fresh image of the enemy.

It's useful to clear away popular misconceptions about tsunamis, such as the notion of a single, monstrous wave that appears out of nowhere to engulf a sleeping village. While it's true tsunamis often catch people by surprise, a tsunami isn't a single wave; it's a series of waves, and it usually isn't the first wave that's biggest, but perhaps the third or fourth wave. And sometimes the first thing that happens isn't a wave at all, but a mysterious withdrawal of the sea that leaves fish flopping on bare sand—followed by a big wave. This variety often traps the unwary.

Mark Spaeth, tsunami-warning specialist now attached to the National Weather Service, says: "There isn't any such thing as a typical tsunami. Each one is different."

But, as he points out, there are some common demoninators. He says you can get some idea why a tsunami is always a series of waves by recalling what happens when you toss a pebble into a glassy pool. The resultant splash produces not just one widening circle but a series. The same is true of the tsunami, only on a colossal scale. An earthquake on the sea floor sets in motion the water in its immediate vicinity. This disturbed water vibrates ponderously back and forth producing shock waves that race outward in all directions at jet-plane speed.

Curiously, ships at sea cannot detect the waves as they race along; nor can aircraft looking down. The successive waves of a tsunami in deep water are so far apart—say, 100 miles and 15 minutes—and so low in height, maybe a couple of feet—and so extremely gradual in slope, that they are literally undetectable. It's when they reach shoal areas that they are transformed into terrifying monsters as tall as 100 feet.

Dr. William Quinn, the Weather Service's former Assistant Director of Oceanography, said tsunamis are unique among all the waves on the oceans. "There is nothing quite like a tsunami in the entire spectrum of wind-driven waves, even though some of the latter may be 30- to 40-feet tall or more and be separated crest-to-crest by 8 or 9 seconds. A tsunami is unique in the amount of energy it contains. While the typical height of a tsunami in deep ocean is only a foot or two, that wave has a tremendous amount of energy, reflected by the long period between crests—anywhere from 15 minutes to a couple of hours."

That energy becomes readily apparent when a tsunami wave reaches shore. "One thing people frequently remark on about a tsunami," said Quinn, "is that it just keeps coming and coming and coming, so they wonder when it's going to stop." At times the Jekyll and Hyde nature of the tsunami has been observed with astonishment by sailors. Spaeth said that, "During the 1946 tsunami at Hawaii, the crew of a freighter sitting about a mile off Hilo was watching waves break over the tops of warehouses on shore and into the town . . . but as far as they could tell there was nothing going by them."

Quinn explained a little of the physics behind this puzzling contrast. "To an oceanographer," he said, "a tsunami wave is a shallow-water wave, even when passing through the deepest part of the oceans. A shallow-water wave is one where the wave length (the distance between crests) is much greater that the water depth. So, even though a tsunami may be crossing an ocean basin three miles deep, the waves are still classified as shallow-water waves because their length is so great—often more than a hundred miles. The next important fact to note is that the speed of any shallow-water wave is proportional to the square root of the depth of the water. With a little mathematics, you find that a tsunami wave in water 18,000 feet deep travels about 500 miles an hour, in water 900 feet deep, 115 miles an hour, and in 60 feet, 30 miles an hour.

"When a tsunami approaches shore, shoaling causes its waves to telescope by increasingly restricting their forward motion as the water grows shallower and shallower. Also, the waves grow taller and the distance between them shrinks.

"In this fashion a 2-foot wave traveling 500 miles an hour in deep water becomes a 100-foot killer traveling 30 miles an hour when it approaches shore.

"Throughout, though, the time interval between crests tends to remain large. That's one of the most significant characteristics of a tsunami at any stage."

Both Spaeth and Quinn are quick to point out that the effect of the same tsunami wave may be vastly different from one point on shore to another. Local topography is usually responsible. For example: A bay or an estuary has a funneling effect, which accentuates the height of the wave; an offshore shoal or sandbar diminishes it. This is why in one area the wave may be 50 feet tall and, at a few miles distant point, 5 feet tall.

It is the fundamental relationship between the speed of a tsunami wave and the water depth which has permitted scientists to produce a workable warning system. Accurate tsunami travel-time charts have been prepared for populated points throughout the Pacific basin and its borders. These charts, according to Spaeth, are accurate to within about 3 percent, or, plus or minus 1.8 minutes for every hour of tsunami travel. The arrival of the first tsunami wave to hit Crescent City, Calif., after the 1964 Alaskan earthquake was predicted to within 5 or 10 minutes, he said. It took about four hours to travel from Alaska to California. Sometimes the warning interval can be as great as 24 hours. This would be the case for a tsunami generated by an earthquake off Chile, traveling across the Pacific to Japan—or vice versa.

Tsunamis do maintain strength for such great distances. The great Karkatoa volcanic explosion of 1883 produced tsunami waves which traveled two or three times around the globe, said Quinn.

Although the Pacific-wide warning system has its headquarters in Hawaii, there is an associated regional tsunami-warning system in Alaska. This was established after the '64 quake to provide quick local response to seismic events in that earthquake-prone state. An earthquake in the immediate vicinity of Alaskan ports causes a tsunami within minutes. So there is no time to lose.

A fraternity of a dozen nations participates with the U.S. in the Pacific warning net, including Japan, the Philippines, New Zealand, Chile, Argentina, Peru, El Salvador, Mexico, Canada, Great Britain (Hong Kong), and France (French Polynesia). Observers are also located on a host of Pacific islands large and small. There are two types of stations involved: 31 seismological stations to detect earthquakes, and 50 tide stations to see if a tsunami follows the earthquakes.

As described by Spaeth, the reporting system works roughly like this:

Mark Spaeth (left), tsunami warning expert attached to the National Weather Service and Dr. William Quinn, the Weather Service's former Assistant Director of Oceanography.

"An earthquake occurs and triggers alarms in several seismological observatories. The seismologists then inspect their records and pick off the key phases (arrival times of the primary and secondary waves) of the earthquake. With these they know how far away the earthquake is from their particular instruments.

"This information is flashed to Honolulu. It's extremely important data. With enough of these key phases—you have to have at least three—the Honolulu Observatory can determine where the epicenter is.

"Honolulu also computes the magnitude of the earthquake, and so does the seismologist at the Palmer Observatory in Alaska, as a matter of routine.

"Then, once the epicenter has been determined, and if it falls in an area where tsunami generation is possible, and if the magnitude is large enough—7½ or greater on the Richter Scale—the Honolulu Observatory will issue a Tsunami Watch. This goes to all the dissemination agencies that participate in the warning system—Civil Defense, military, local police, wire services, and so on, and thence to the public.

"Concurrently with issuance of the watch, Honolulu contacts the tide stations nearest to the earthquake for indications that a tsunami has been generated. If they get confirmation, they will go out to the dissemination agencies with a Tsunami Warning. When the warning is issued, they give estimated arrival times for the first wave of the tsunami at about 50 locations scattered around the Pacific.

"These happen to be the tide stations in the warning system. Each has a tsunami travel time chart for that station so the observer can make his own calculations of just how long it will take a tsunami to reach him from any point in the Pacific. This helps him narrow the bracket of when to look for the passage of the tsunami past his gage, so he can report it to Honolulu.

"By this means we monitor the progress of the tsunami as it passes across the Pacific. Finally, we advise local Civil Defense and other agencies on when it's possible to cancel the warning action in this area, although we leave it up to them to do it. After a tsunami has occurred, we say that generally the danger is ended for a given area when it has been free from damaging waves for two hours."

A substantial period of watchful waiting before issuing an all-clear is advised for good reason. The long gap between successive tsunami waves has lulled a number of people to return too soon to evacuated areas—so that they were trapped and drowned by a successor wave, perhaps the biggest of all.

Although predictions of arrival times for first waves of tsunamis are satisfyingly accurate, predictions of tsunami magnitude are not. In fact, scientists say, it is not now possible even to tell if a known tsunami will have any significant effect at all on shore. So tsunami warnings do not carry estimates of just how high the water will rise, as hurricane warnings do for wind-generated storm surges. Consequently, there is an inescapable amount of overwarning.

The reason is the bewildering number of local effects that can cause variations in tsunamis, says Spaeth. Although scientists are hard at work on the problem—through such efforts as the Joint Tsunami Research Effort between NOAA's Environmental Research Laboratories and the University of Hawaii—both Spaeth and Quinn predict the solution is a long way off. "Not as far off as earthquake prediction, perhaps," said Spaeth, "but still a long way." He added:

"We keep running into new problems. Take the Alaskan tsunami of 1964. There's a place called Port Alberni on Vancouver Island, British Columbia, roughly 35 miles from open water at the end of a long, narrow fjord averaging 500 feet deep.

"Well . . . if I had to pick a place that wouldn't have a tsunami problem I would have said that was it. Yet they got roughly a 20-foot wave up at the head of that fjord. And it just wasn't supposed to happen. But what evidently occurred was that the natural period of oscillation in that fjord was about 95 minutes, which we think was the same as for the tsunami. Result was that as the tsunami drained out and was pumped back in, it was reinforced by the natural period of the fjord."

This reinforcing effect is what scientists call a seiche, and occurs most often in landlocked seas or bodies such as the Great Lakes when a squall line sets up the natural period of oscillation. One way to visualize what happens is to recall how a child gains height in a playground swing. A pull of the hands or a pump of the legs at the beginning of the downswing gradually increases the arc. Only with a seiche it's more like you were tipping a dishpan at just the right moment.

Another of the puzzles involving tsunamis is why it usually is not the first wave that causes the damage but a later wave. Logic suggests the first, as occurs when a boisterous prankster cannonballs into the water beside you in a swimming pool. "But it's very seldom except right near the source that the first wave is largest," said Spaeth. "I've seen records where the maximum wave might have occurred 24 hours after the first. And it wasn't because there were continuous tremors for that long a period."

Scientists aren't sure why the variation, but it has been observed numerous times. Sometimes the big tsunami wave will be what is known as a bore, which occurs when one wave overtakes a preceding wave, producing a steep-faced "wall of water."

One of the most destructive of these was associated with the Chilean tsunami of May 1960, which inflicted major damage on the city of Hilo, Hawaii. Fortunately, at that time the Tsunami-Warning System was a going concern, and the death toll—61—was much less than for previous, comparable tsunamis because of timely warnings.

This tsunami was so carefully documented that it is worth examining in detail.

It was triggered by an earthquake which shook Chile on May 22, 1960. As early as 11 a.m. in Hawaii it was known that a major earthquake had occurred near Concepcion, Chile. Tsunami travel-time charts indicated seismic sea waves would reach Hawaii about midnight, more than 12 hours later. News flashes from the mainland soon confirmed destructive waves along the Chilean coast. This long lead time made possible eyewitness account by three trained obervers—J.P. Eaton, D.H. Richter and W.U. Ault—which appeared in a report prepared for the Federal Government shortly afterward. A condensation follows:

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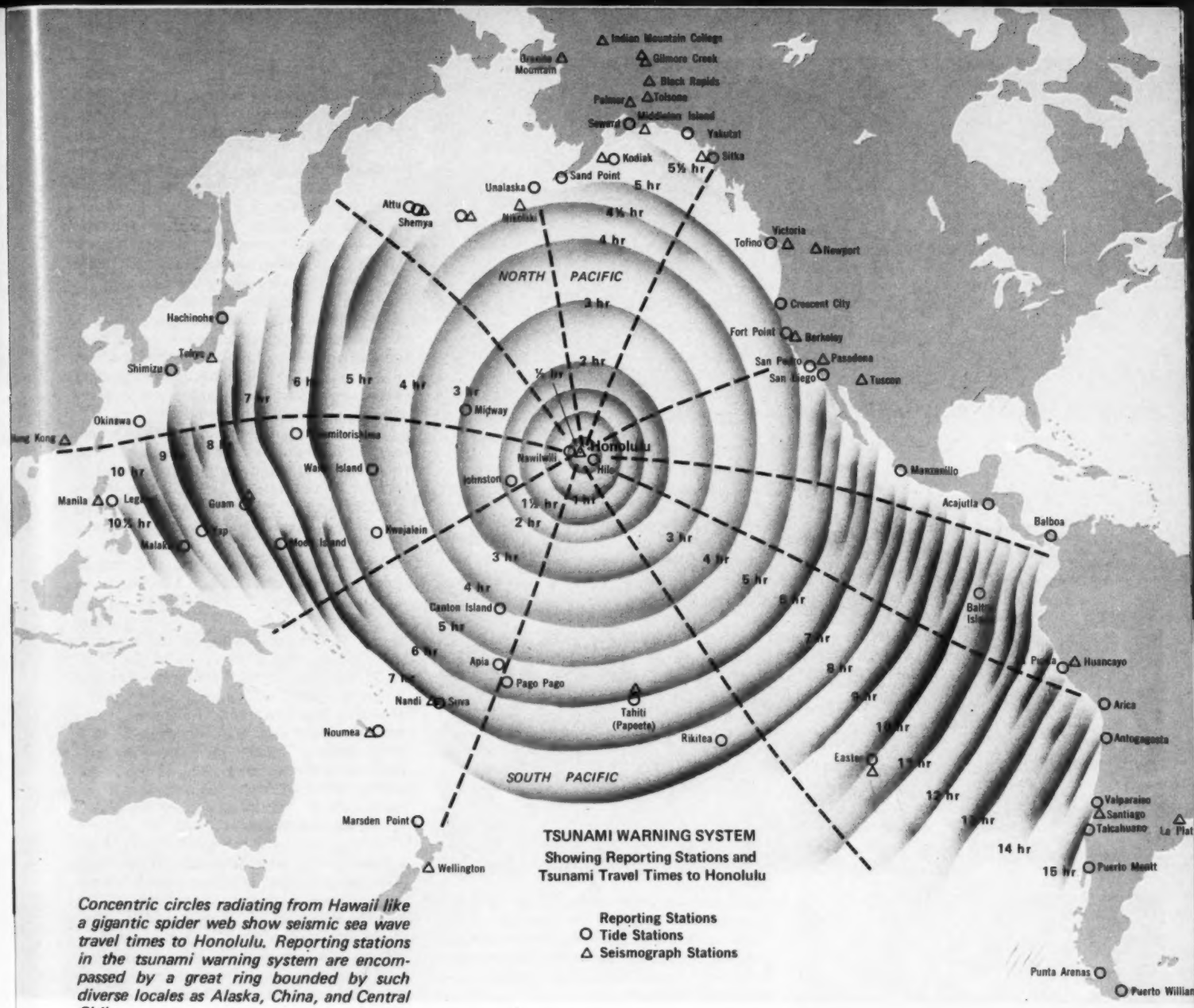
"At 6:47 p.m. the U.S. Coast and Geodetic Survey Honolulu Magnetic Observatory . . . issued a seismic sea-wave warning and estimated that a tsunami might reach Hawaii at about midnight. At 8:30 p.m. coastal sirens in the Hilo area were sounded to warn people to leave low-lying areas for higher ground . . .

"Feeling that useful observations could be made in spite of darkness, a group [of us] from the U.S. Geological Survey . . . and Hawaii National Park set out for Hilo



Concentric circles radiating from Hawaii like a gigantic spider web show seismic sea wave travel times to Honolulu. Reporting stations in the tsunami warning system are encompassed by a great ring bounded by such diverse locales as Alaska, China, and Central Chile.

just before 10 p.m. . . . After discussing our plans with the Hilo police we drove through blocked-off and deserted waterfront streets to our chosen vantage point [on a bridge] . . . From this point at the west end of Hilo Bay we had an excellent view of the harbor . . . Furthermore, a short sprint north along the highway would bring us onto safe high ground.

"At 12:07 a.m. the water beneath the bridge began to rise . . . and at 12:13 a.m. it crested at about four-plus feet. Then it began to fall slowly, reaching a trough of about three-minus feet at 12:30 a.m. . . .

"By 12:40 a.m. the level of the water was back to normal and rising rapidly, as water surged beneath the bridge into the estuary beyond. At 12:46 a.m. the second wave crested at about 9-plus feet and a turbulent, swirling retreat of water from the estuary into the bay began. Later, we learned that the second wave topped the sea wall and flooded [an area] near the center of the business district. . . .

"Water continued to pour out of the estuary, and its level beneath the bridge continued to drop until 1:00 a.m., when measurement with the tape showed it to be nearly 7 feet below the pre-wave water level. For a short while a strange calm prevailed as ground water cascaded from among rocks . . . rarely exposed to view along the shore.

"At first there was only the sound, a dull rumble like a distant train, that came from the darkness far out toward the mouth of the bay. By 1:02 a.m. all could hear the loudening roar as it came closer through the night. As our eyes searched for the source of the ominous noise, a pale wall of tumbling water, the broken crest of the third wave, was caught in the dim light thrown across the water by the lights of Hilo. It . . . seemed to grow in height as it moved steadily toward the bayshore heart of the city.

"At 1:04 a.m. the 20-foot-high nearly vertical front of the inrushing bore churned past our lookout, and we ran a few hundred feet toward safer ground. . . . The top of the incoming current caught . . . the south half of the bridge and sent a spray of water high into the air. Seconds later, brilliant blue-white electrical flashes . . . a few hundred yards south of where we were signaled that the wave had crossed the sea wall and buffer zone and was washing into the town

Hilo, Hawaii, May 23, 1960. As the huge wave rolled inland (shaded area on map), buildings were turned to kindling and for some (bottom) there was no escape from the wall of water.

with crushing force. Flashes from electrical short circuits marked the impact of the wave. . . Dull grating sounds from buildings ground together by the waves and sharp reports from snapped-off power poles emerged from the flooded city. . . At 1:05 a.m. the wave reached the power plant at the south end of the bay, and after a brief greenish electrical arc that lit up the sky above the plant, Hilo and most of the island of Hawaii was plunged into darkness.

"For the next hour we waited at the bridge, recording the rise and fall of the water as additional waves rolled in. Some . . . advanced toward the city as bores, swirling past the bridge and . . . then retreating in a turbulent flood. At least one of the later waves at about 1:50 a.m. poured some water over the sea wall and raised the level of the shallow lake that covered . . . part of Hilo."

Investigators Eaton, Richter and Ault said the tsunami traveled the 6,600 miles from its source along the Chilean coast to Hilo in 14 hours 56 minutes, at an average speed of 442 miles an hour. They estimated that after it reached shallow water it traveled about 7,000 feet from the breakwater to the shore in 2.5 to 3 minutes, or at a velocity of 40 to 45 feet per second. They also provided an excellent account of the damage, from which excerpts follow:

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"By 2:15 a.m. the height of the waves . . . had diminished sufficiently that it appeared to be safe to enter Hilo. . . . Thick slimy mud covered the streets, and fish abandoned by the water . . . were strewn about. . . . Hilo's sewage, dumped inside the harbor entrance, had been stirred up . . . and hurled into the face of the city . . . filling the air with a distressing stench. . . . Broken power poles, tangled wires, yardage goods [from stores] were festooned through wires and muck; children's toys and gasping fish clogged the street, making our progress southward treacherous and slow. . . .

"In the area of total destruction, whole city blocks were literally swept clean of all buildings except those of structural steel or reinforced concrete . . . and a few in the shadow zone of these. . . . Automobiles by the dozens were complete wrecks—some stacked three deep . . . or rolled hundreds of feet, and others were wrapped around trees . . . Concrete sea walls 3 feet high, 14 to 20 inches thick . . . were washed out and long sections were carried 10 feet from shore. . . . Reinforced concrete curbing from the Bayfront Highway . . . in lengths of 20 to 30 feet were carried inland 350 feet and wrapped around stubby steel posts. . . . At Hilo Iron Works a tractor weighing 11 tons and the showroom that contained it were swept away. . . . Large rocks from the bayfront sea wall weighing up to 22 tons were carried 400 to 600 feet inland across Mooheau Park . . . without leaving noticeable grooves across the lawn. . . ."

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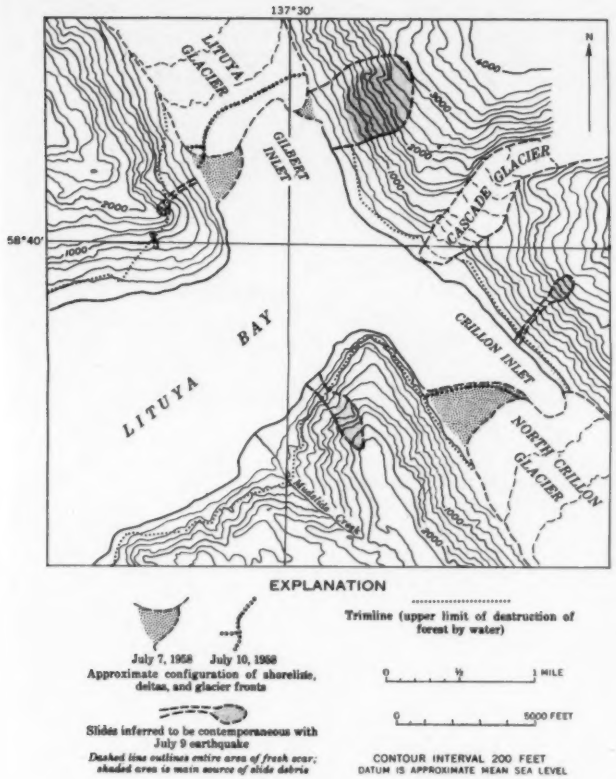
Such is the power of a tsunami. An even more bizarre effect occurred July 9, 1958, in a remote coastal area of Alaska in a T-shaped indentation called Lituya Bay. It is still shrouded in mystery and the subject of controversy, but some investigators believe that a gigantic icefall into the bay, induced by an earthquake, caused water to slosh more than 1,600 feet up a mountainside. Writing in the 1960 Smithsonian Institution Annual Report, Retired Coast Survey Captain Elliot B. Roberts said:

"All the viewers in the days following the wave exclaimed in amazement at the appearance of the western mountain at the corner of Gilbert Inlet [a part of Lituya Bay]. Where it had formerly been tree clad all the way down to the shore, its steep bulwark now stood starkly bare to a height of more than 1,600 feet. The rocks seemed to be washed clean—did this mean that the wave had climbed to the incredible height of 10 Niagaras? There were those . . . who thought so from the first, but mass skepticism met their claim, and the controversy is not yet stilled. There was most certainly a landslide . . . and it is easy to point out that it alone could have denuded the mountain, but this easy explanation falls before the Survey photogrammetrists, experts at

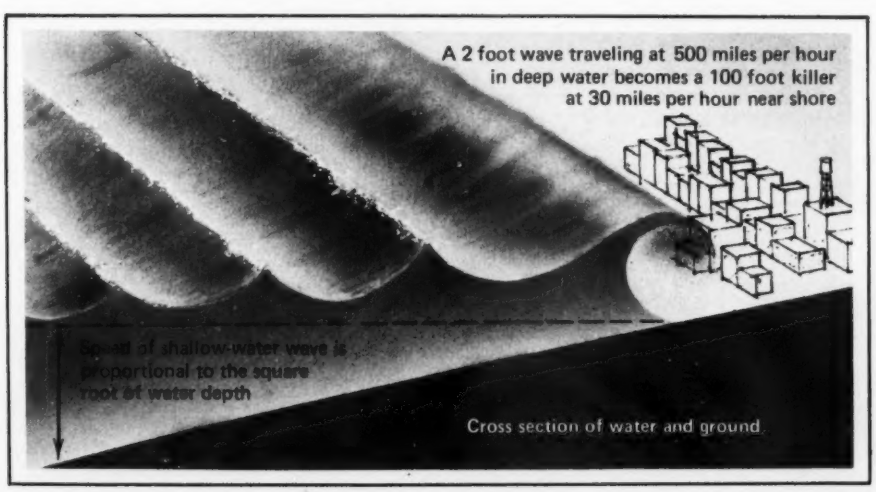


The effects of a great sea wave on Lituya Bay, Alaska, are shown in a "before/after" map and a profile carved by the tsunami in a forest that once extended to the shoreline.

photointerpretation. . . . [They] expressed their unanimous conviction that the water did reach a height somewhere between 1,200 feet and the top of the bared mountainside area. It was apparent to them that nothing but an actual flood could possibly have scoured the folded and creviced rocks so thoroughly clean of every bit of dirt and debris—certainly not the landslide alone. . . .

"It seems that the Lituya Bay wave of 1958, a true tsunami in the original sense of 'wave-in-a-bay,' unbelievably but in all probability threw its foaming crest higher than any wave ever before known to man."

Captain Elliott further wrote that eyewitnesses in two boats in the bay who miraculously survived told of "writhing and twisting of the high peaks" during the quake, followed by a "gigantic wall of water" which erupted against the mountain and then caromed down the bay. Occupants of one boat said they were lifted across a spit at the mouth of the bay and at one point "believed they were 100 feet high, for there had been trees on the spit, and they were above them. They looked down on rocks as big as houses." Their boat was wrecked but they escaped in an 8-foot punt. The other boat, a 38-footer, "was swept, completely out of control, over what had been dry land a moment before." Then the wave changed course and allowed the skipper, "with superb seamanship," to make his way to the safety of open water. "Three giant combers had broken over the tiny pilothouse" before his escape.


A 2 foot wave traveling at 500 miles per hour in deep water becomes a 100 foot killer at 30 miles per hour near shore
Speed of shallow-water wave is proportional to the square root of water depth
Cross section of water and ground

Although few accounts of tsunamis can match this for sheer awesome spectacle, the literature abounds with expressions of utter amazement at their size and power.

Since 1948, fortunately, the surprise element of their arrival, at least, has been eliminated for coastal populations. NOAA's National Ocean Survey undoubtedly saved many lives in and around the Pacific during the Chilean tsunami of 1960 and the Alaskan tsunami of 1964. Now, the Honolulu, Hawaii, and Palmer and Adak, Alaska, Observatories, newly aligned with the National Weather Service, hope to create a still stronger and more-responsive team to spread the alarm.

As with all sentries for natural disasters where time is precious, the tsunami watchers hope for faster communications between their farflung outposts and those in need of warning. The technological development that could make this possible is the geostationary satellite, such as NOAA's GOES, slated for launch this year.

Said Mark Spaeth: "We do have serious communications problems getting tide-gage data out of remote places like Easter Island or the Galapagos. Sometimes we might have to wait a half hour, or even several hours if we're unlucky, for a critical report, depending on the time of day and other traffic. If we were to work through a geostationary satellite, which would require only a single relay point between a remote Pacific Island and NOAA's satellite-acquisition station at Wallops Station, Virginia, this would certainly be a big improvement." □

NOAA Profile

catch the rising sun

BY JOAN VANDIVER FRISCH

As the glowing sun clears the distant horizon, a petite astronomer takes aim with a 32,000-pound telescope, in an isolated location known as Sunspot, N.M. She's Dr. Constance Bragdon Sawyer, a 100-pound visiting scientist from the Environmental Research Laboratories' Boulder, Colo.-based Space Environmetal Laboratory. The soft-spoken woman is one of approximately 40 scientific and technical staff and visitors who work at the densely wooded, 9,200-foot-high site.

Dr. Sawyer's work involves observing, photographing, and analyzing the sun using instruments within the Big Dome—one of the two major observational complexes at the New Mexico observatory. Her mission—to do basic research on the sun, and to supply daily solar pictures to the Environmental Research Laboratories' Space Environmental Services Center in Boulder, Colo., and to ATM Skylab scientists at Johnson Space Center, Houston, Texas.

"The spar in Sacramento Peak's Big Dome carries several telescopes which are designed to observe the surface of the sun and different parts of its atmosphere," Dr. Sawyer explains. "A number of separate telescopes—the largest of which is a 16-inch coronagraph—are attached to a 26-foot spar. Electronic signals from this instrument are carried into an observing room below the telescope mounting."

On the near side of the spar is an 15-inch chromospheric and prominence telescope that is used with a filter to admit light only from the sun's lower atmosphere (the chromosphere). A 35-millimeter movie camera at the bottom of the spar photographs the chromosphere and prominences, huge clouds of dense gas visible at the edge of the solar disc. With this instrument astronomers can investigate the turbulent action above the sun's surface.

"The magnetic fields on the sun's surface are measured and studied with an instrument called a magnetograph, attached to the spar," Dr. Sawyer says. "This instrument reveals intense magnetic fields in active solar regions around sunspots, hundreds of times stronger than the magnetic field of the earth. Astronomers believe that changes in these magnetic fields must be the energy source for flares that occur almost daily on the sun.

"A big flare puts out X-rays, ultraviolet radiation and energetic protons that could endanger exposed astronauts, and disturb the earth's magnetic field and ionosphere, disrupting communications. Predicting these disturbances and the solar activity that cause them is one of the missions of the Space Environment Laboratory's Services Center, directed by R. B. Doeker. Monitoring and forecoasting solar activity is essential to effective use of Skylab's complex solar instruments, and the responsibility for providing this information is NOAA's."

As the spar and dome rotate automatically to follow the sun, Dr. Sawyer and her colleagues control most of the telescopes from one or another observing rooms.

"We catch the rising sun at 7 a.m. in summer, 8 a.m. in winter," she says. "Then we aim the telescope and spectroheliograph, which selects a certain wave length, and builds up a photographic image of the sun in light of that particular color—for example, the K-line emitted and absorbed by calcium ions, shows us the upper chromosphere.

"Most people have seen sunlight that has passed through a prism, or been reflected from a grating, so it is spread out into its component colors, arranged in order of wavelength. This is the principle on which a spectroheliograph operates. At different colors or wavelengths, we observe bright or dark lines in the solar spectrum. These lines are like fingerprints, telling us which elements are present in the sun's atmosphere. By careful study of these fingerprints, we can tell how much of each element is present, the speed at which the atoms or ions are moving, strength of any magnetic fields on the sun's surface, and the temperature of the surface of the sun."

Precise programming links the telescopes to a computer that controls the scanning of an active region and automatically stores the measurements. Another computer program presents the data in the form of a map, showing the magnetic fields in an active area of the sun, of particular interest to Skylab scientists. Several Sacramento Peak scientists have collaborative programs with the Apollo Telescope Mount (ATM) on

Dawrfed by huge spar supporting telescopes in Sacramento Peak Observatory, Dr. Constance Sawyer gathers data. Above, she relays it by hotline to NOAA. Below, relaxing with younger son Joel, seven.

Skylab, photographing the sun at ground observatories simultaneously with cameras aboard Skylab in space. Dr. Sawyer and John Busman, another Space Environment scientist share the observational work, which includes reducing data taken by the coronagraph and using the computer to present the data in map form for Skylab purposes. In Busman's absence, Dr. Sawyer spends an hour or two a day observing and another couple of hours getting the data reduced and sent off by photofacsimile or telecopier to Houston's Johnson Space Center, Boulder's Forecast Center, and other interested facilities.

However, the bulk of Dr. Sawyer's time is spent in doing research. She has just completed a paper showing that wave-like motions in the sun's chromosphere have different periods in different places. The NOAA astronomer believes that the difference is caused by the magnetic field, and that by measuring this period, scientists have a way of estimating the strength of the field—a feat they have been unable to do for the high chromosphere before now. Dr. Sawyer is also working with a husband-wife team—Richard and Shirley Hansen—of the National Center for Atmospheric Research High Altitude Observatory on the relation of intensity maximum in the corona to the magnetic-field sector structure in interplanetary space. In addition, she has been looking at archived movies in Sacramento Peak's extensive collection of solar flare-patrol films at times of occurrence of a newly identified type of radio-frequency burst. The solar astronomer is trying to find some pattern or relation between the radio event and the visible (in hydrogen alpha light) chromospheric activity.

When she is not working, she enjoys many other activities—indoors and out.

"Sacramento Peak has great hiking trails and wildlife, including an occasional deer on my front lawn," the astronomer says. "Like many of the staff and families, I live right on the peak—a 10-minute walk to work over forest paths. The remoteness presents both advantages and disadvantages—wild flowers abound within a few feet of my door, and friends can camp anywhere within the surrounding Lincoln National Forest. People take the time to share their knowledge of music, ceramics, crafts, yoga, or Eastern cookery. And there is a wonderful feeling of community support and concern for each member. On the other hand, the children must travel by bus to school in Cloudcroft—a small resort town a half hour away, and we have to go to Alamogordo, an hour away, for most supplies or any 'live' concerts or plays. Of course I miss Boulder's lively organizations and events."

In Boulder, Dr. Sawyer became consciously concerned about the attainment of equal rights for men and women. As a result, she participated with other members of the National Organization for Women in discussing local problems of inequality of employment with officials of the public schools, of the city government, and of the University of Colorado before she left Boulder. As coordinator of the local NOW chapter's Employment Task Force, the ERL astronomer was instrumental in planning, organizing and evaluating the efforts of about a dozen women informing the public and employers about new legislation, identifying non-complying employers, and applying various pressures toward compliance. Through a Corps of Advocates she has shared information about how to obtain one's civil rights with women who have suffered discrimination.

Dr. Sawyer began her interest in astronomy at an early age.

"I decided to become an astronomer when I was about 10 years old," she explains. "While neither of my parents were astronomers, they were involved in science. My father was chairman of the biology department at Bates College in Lewiston, Maine, and my mother taught biology during World War I."

To pursue her field, she received an A.B. degree in astronomy from Smith College in Northampton, Mass. A year later she earned her M.S. degree from Radcliffe College in Cambridge, Mass. Four years later she received her Ph.D. in astrophysics from the same institution, and twenty years later, along with all Radcliffe graduates, a retrospective Harvard degree.

After completing her studies, the Phi Beta Kappa astronomer joined the staff at Sacramento Peak, then part of Harvard College Observatory. Three years later, she and her family moved to Boulder, Colo., where she worked at the University of Colorado's High Altitude Observatory. Since 1958, she has been employed by what is now NOAA as an astronomer in solar-terrestrial relationships.

During her career as a scientist, wife and mother, she has managed to publish over 70 research papers in galactic structure, solar activity, and sun-earth relations. For the first time in her 20-year career she was invited recently to chair a session at meetings of a scientific society—"Affirmative Action by the American Geophysical Union," she says. While at NOAA, she has taught graduate-level courses in the University of Colorado's Departments of Astrogeophysics and Aeronautical Science. In addition, she has done volunteer work for the juvenile court in Boulder, served as a foster parent, and worked for Attention Homes—homes away-from-home for troubled teen-agers, and participated in a pilot program in the public schools in individual tutoring of children with learning disabilities.

Professionally, Dr. Sawyer has acted as project leader, supervising the work of several scientists and technicians, while planning and carrying out research activities within the goals of the laboratory. In the past she has served on the Editorial Committee of the Space Environment Laboratory, and on its Promotion Review Committee.

Three of her children are grown. Sarah, 23, the eldest, is an honor graduate of the University of Chicago, where she majored in history of the Renaissance and Reformation. She now is employed by a legal firm in Paris. The two middle children are both studying at Colorado State University in Fort Collins. David, 21, plans to major in political science and law, while Rachel, 18, recently graduated from Interlochen Arts Academy near Traverse City, Mich., is interested in weaving, dance and music. Joel, 7, her younger son, is in second grade in Cloudcroft, N.M.

"Since leaving home, my older three children have all become competent managers," she says. "David can now cook, shop, clean, and launder about as well as any of them. He knows enough about women's liberation to drive either of his sisters up the wall with a few remarks, skillfully placed. Though both girls express doubts about commitment to a career at this point, I think each wants to explore the world a bit, more than she wants the immediate security of marriage that was the goal of my generation of women. After a lot of worrying about the children, I'm pretty happy about them now, because I feel that they are reasonably happy, busy, and growing." □

Real-time surveillance plus long-term planning help Great Lakes shippers in

DEFEATING THE ICE PACK

BY JOHN HANNA

Early in February, 1973. Downbound on the St. Marys River between Ontario and Michigan's upper peninsula, an ore carrier pushed its way through blue ice and a blinding snowstorm. Traversing a part of the Great Lakes that had heretofore been closed to shipping at that time of the year, it was one of a small fleet of vessels taking part in an interagency Winter Navigation Demonstration program. The purpose was to determine if extended navigation is feasible on the Great Lakes.

The success of experimental voyages such as this was made possible by continual monitoring of ice conditions, quick communications to the ships, and, where necessary, assistance from Coast Guard icebreakers standing by. The success of a long-term program will depend upon the experience of several seasons of operations. Careful planning and analysis is now going on in seven work groups that together, under the leadership of the U.S. Army Corps of Engineers, form the program.

NOAA's Lake Survey Center is lead agency for the Ice Information Work Group, which operates the Ice Navigation Center in Cleveland, Ohio—key to the real time ice monitoring and communications that the big ships depend upon for winter navigation help.

It is difficult for those not associated with the Great Lakes to understand the size of the problem. When Lake St. Clair freezes solid enough so that automobiles can be driven out on the ice sheet, navigation is hazardous at best. Harbors in the west end of Lake Superior have recorded thicknesses of up to four feet of solid ice. On some rivers, ice jams that can cause flooding and severe erosion have been known to extend 30 feet below the water surface and as much as 15 feet above it. Similar phenomena occur in open lake areas when pack ice is driven by wind and water currents into what are called windows. Again, navigation in these situations is virtually impossible.

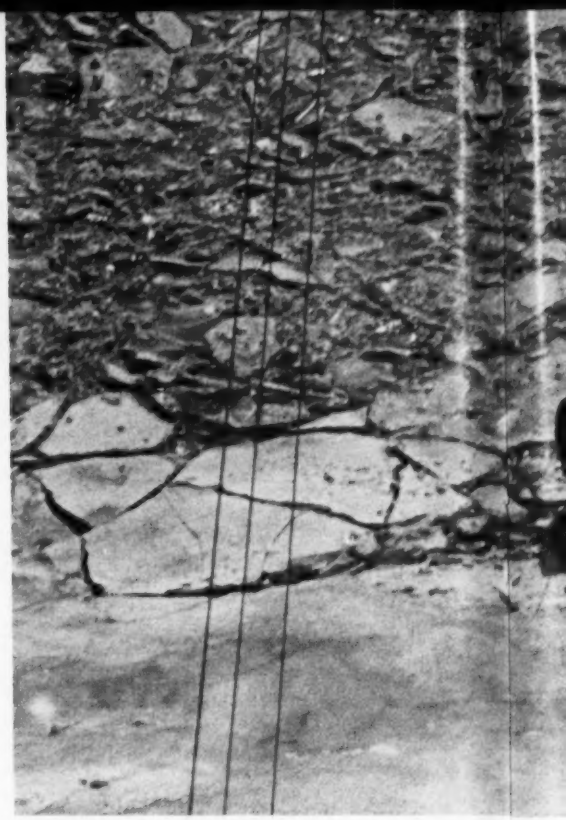
Oddly, navigation is even more difficult during ice break-up in late winter than during the earlier hard ice period. "Slush ice", cohesive and resilient, forms and clings to the sides of vessels. Thickness of six to eight feet, not uncommon, can stop a freighter.

There are two parts to the Winter Navigation program—inter-Great Lakes traffic, and Great Lakes-to-ocean traffic. Critical areas for the lakes-only traffic are northern harbors, Whitefish Bay on Eastern Lake Superior, St. Marys River, Straits of Mackinac, St. Clair River, Eastern Lake Erie in late winter and the Welland Canal. The ocean-going ships are additionally concerned about that part of the St. Lawrence Seaway extending from Lake Ontario to Montreal. (Montreal Harbor is kept open year-round, usually with the aid of Canadian icebreakers)

Not all problems associated with Great Lakes winter navigation are so obvious. For example, what are the environmental effects on breaking up or attempting to control the formation of ice? How does the vessel master navigate without the aid of channel buoys?—in blinding snow storms and shorter hours of daylight?—with obscured day marks and ranges? Can such an effort be economically feasible? What is the effect on the men who sail under such hazardous conditions? And what about their safety?

Of the seven work groups, the Ice Information Work Group is perhaps that most intimately concerned with the day-to-day operations of ships in the ice. At the Ice Navigation Center, Daron Boyce of the National Weather Service works together with a team of Coast Guardsmen—including QMC Robert Swain and RD1 James Burrell—to collect the weather and ice data needed, put together such reports as a daily ice summary and ice analysis composite charts, and get the material back to commercial ships, Coast Guard stations and icebreakers, and other users.

Each day the team receives, by teletype and facsimile, the results of aerial ice reconnaissance flights and photo missions,



Winter on the Lakes: a tug opens an early season navigation channel (above); an island ferry pushes through mid-season ice (below left); a big ship closes the 1972 navigation season. (Photos: St. Lawrence Seaway Development Corp.; Corps of Engineers).

satellite photos, reports from the Lake Survey Center and from 53 Coast Guard stations around the lakes, as well as information from vessels underway. The Canadian Ice Service cooperates in information exchange. Boyce, the meteorologist of the group, concentrates on the weather forecasting job, though the men all work closely as a team, helping each other out and supplementing the efforts of others with their own contributions.

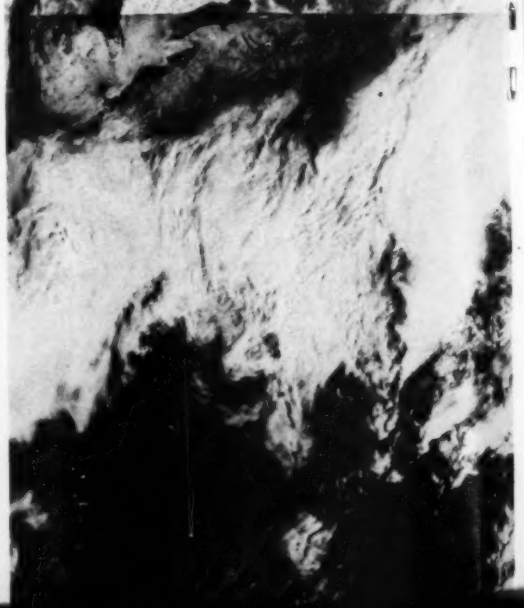
Among the data they receive are air and water temperatures at critical locations, ice thickness at selected sites, and water level measurements in certain areas. The latter, when monitored closely, can signal the forming of ice jams, a danger point that the team must watch out for.

In addition to filing daily analyses and reports by teletype to the ships and stations that need the information on a real-time basis, the team mails daily ice summaries to industry, shippers, and other user groups. Other activities include briefing sessions held several times each season for the Lake Carriers Association, at which they provide the Association with the NWS 90-day weather outlook and ice forecast, and in return obtain information on how many vessels the association plans to run during the season.

The Ice Navigation Center opens about December 15, and is in operation seven days a week throughout the ice season.

In addition to its operation of this center, the Ice Information Work Group carries out such projects as time-lapse photography to study ice formation and movement, providing short and long-term ice and meteorological forecasts, studying the environmental effects of breaking ice in restricted waters,

Daron Boyce, NWS, and QMC Robert Swain, USCG, work with weather map facsimile at Ice Navigation Center in Cleveland (above) while other Coastguardsmen prepare ice chart of the Great Lakes (above right); a critical ice area on Whitefish Bay at approaches to Seault Ste. Marie locks is indicated by Lake Survey Center staffer (below); NOAA satellite photo of the Great Lakes-St. Lawrence Seaway System on Feb. 28, 1973, shows ice-free Lake Michigan (center left of photo), heavy ice in lower Lake Huron, southern Lake Erie, eastern Lake Ontario, and St. Lawrence seaway.

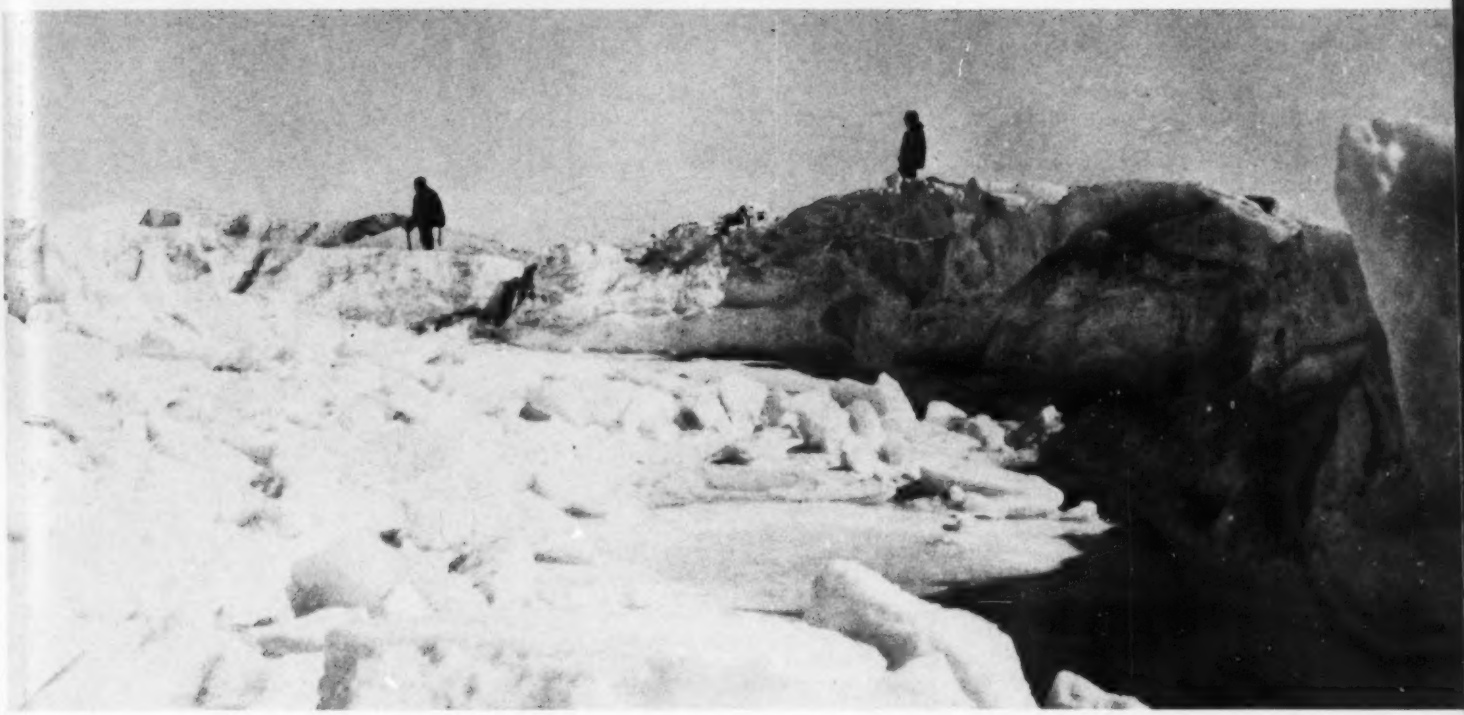


and using satellite photograph and other imagery techniques.

An important project of this Group is the forecasting of freeze-up on the St. Lawrence River. Comparative water temperature analyses are a key to these forecasts.

There are three related elements to PL 91–611, the law that authorized the Winter Navigation Program. One is an ongoing detailed survey study by the Corps of Engineers, to determine the economic justification, engineering practicality and environmental and social impacts of an extended season. A three-year action program to demonstrate the practicality of extending the navigation season on the Great Lakes-Seaway system is also in full swing, with the Army's Chief of Engineers carrying out the major part of the effort, in cooperation with the Departments of Commerce, Interior and Transportation, and the Environmental Protection Agency. Third is a study, already completed by the Maritime Administration, of ways and means to provide reasonable insurance rates for shippers and vessels engaged in waterborne commerce beyond the current navigation season. In addition, the Federal Power Commission, Great Lakes Commission, Great Lakes Basin Commission and technical advisors from the National Aeronautics and Space Administration and the Atomic Energy Commission, are also involved in the program. Special observers from Canada, which has its own program, provide coordination and liaison.

Prior to the first year of the program (FY '72) efforts were directed toward mobilization, planning and investigating various systems and proposals. The early, careful analysis and study produced a unified and systematic approach that led to authorization for a two-year continuation of the program. Specific areas of concern were identified, and the seven work groups established and staffed by experts and specialists in the fields outlined. In charge overall is the Winter Navigation Board, whose members are senior representatives of the agencies involved. Major General Ernest Graves, Division Engineer, North Central Division, Corps of Engineers is Board Chairman with Rear Admiral Albert A. Heckman, Commandant Ninth Coast Guard District,



Winter navigation problems: Lake Survey Center scientists inspect huge pressure ridges and windrows on Lake Superior (above); the Corps of Engineers used this boat sled to transport island resident of the St. Marys River back and forth to the mainland during difficult navigation periods.

U.S.C.G., as Vice Chairman. NOAA is represented by Rear Admiral Harley D. Nygren.

The other six work groups are deeply involved in engineering design, planning, and methods development. For example, the Ice Navigation Work Group is dedicated to improving present methods and procedures for navigating under hazardous winter conditions. Under the leadership of the U.S. Coast Guard this group is looking into vessel construction and reinforcement, aids to navigation and breaking and removing ice, as well as a special assignment to investigate personnel safety and survival equipment. Because conventional aids to navigation cannot be deployed or are ineffective, experimental systems have been designed. Included are structurally reinforced buoys utilizing unconventional anchoring methods, special hull coatings to lower ice friction, air and water bubbler ice-breaking, laser and special radar units for precise all-weather navigation in restricted channels, and a "follow-the-wire" project which uses an energized cable on the channel bottom with special detecting equipment aboard the vessel. Most systems are in the field testing and development stage.

Safety of personnel and provision of effective survival equipment—a U.S. Coast Guard project—is receiving high priority. Among the projects being investigated are specal clothing, and a unique single davit that can be operated from the 25-man life raft it is lowering.

The Corps' Cold Regions Research and Engineering Laboratory (CRREL) heads the Ice Engineering Work Group. CRREL scientists have a wealth of knowledge and experience in the testing and development of equipment and procedures for operating under extreme winter conditions. This group's mission is to determine the forces at work on structures exposed to ice and to develop design criteria for those required to withstand such forces.

One of the group's most vital projects is measuring forces on ice-booms. An ice-boom is a series of large timbers connected end-to-end and stretched across a water area. The purpose is to retard surface currents, thus promoting a stable ice cover upstream. A stable ice cover in most cases insures uniform flow to hydroelectric power plants, reduces the chance of ice jams, and has a stabilizing effect on water levels. Precise data on the forces acting on an ice-boom—as well as on pilings, bridge piers and similar structures—is essential to improved design.

Other Ice Engineering projects include the study of certain ice types which are especially difficult to navigate, analyzing ice properties in support of studies of ice breaking by uncoventional methods and the physics of ice failures.

The Ice Control Work Group's efforts are similar to those of the Ice Navigation Work Group except that they are directed primarily towards the International Section of the St. Lawrence River. The group is under the direction of the St. Lawrence Seaway Development Corporation. Two areas are

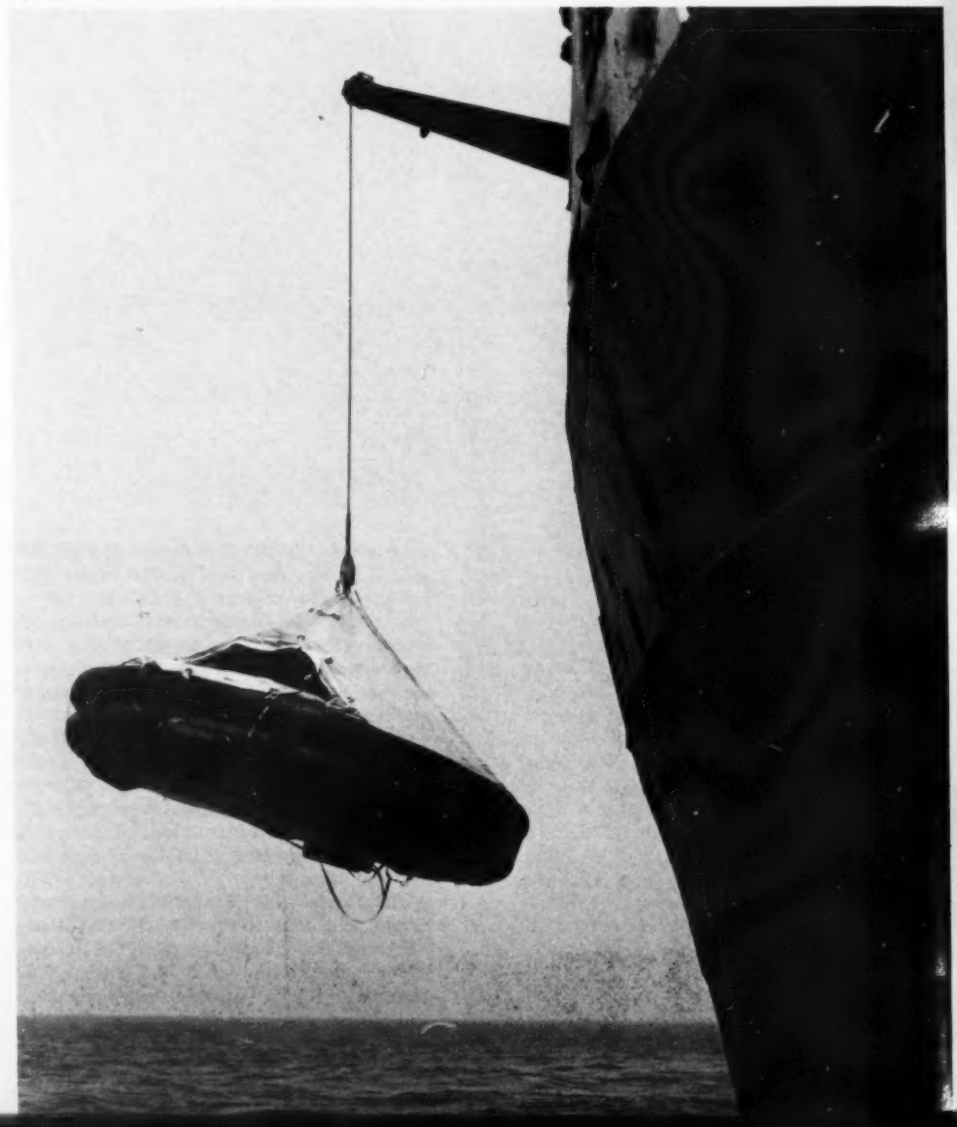
receiving detailed attention: (1) navigation through locks, which is difficult because of ice buildup in gate recesses and on lock walls and (2) navigation through areas which have been conventionally blocked by ice booms. As noted in the discussion of the Ice Engineering Work Group's project, ice-booms serve a very definite and useful purpose and to breach them for navigational purposes can be a delicate proposition. To accommodate navigation and still retain the desirable features of the ice boom, the Work Group designed an experimental gate for installation in the boom, and officials are optimistic about its operation. Bubbler systems have been installed and have been successful in reducing ice buildup in lock recesses.

Other efforts by this group are generally in the developmental or preliminary planning stage and include methods for suppressing ice formation and hastening its decay, and investigating other methods for promoting a stable ice cover.

The Ice Management Work Group has the task of studying and developing means for accomplishing winter navigation in harbors, locks and channels. It is headed by the Corps of Engineers. A unique phenomenom may some day be the key to the success of this group. It is the fact that in winter water in lakes and rivers is warmer at the bottom than at the surface. When air bubbles are released from the bottom they tend to bring the warmer water upwards thus reducing or eliminating ice cover over a narrow area. Air bubblers, compressed air through nozzled tubing on the bottom, have been successful at Duluth Harbor and in the troublesome Lime Island section of the St. Marys River.

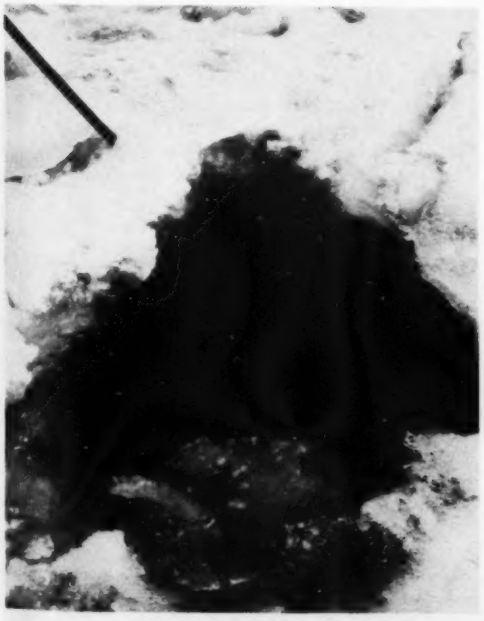
Some of this Group's other projects, either in the planning or development stage, are investigating the possibility of using warm water plant discharge for ice control (a project that will also consider environmental effects as they relate primarily to the Great Lakes fishery), and refinement of remote sensing techniques by NASA using side-looking radar imagery that does not require ideal meteorological conditions to operate. The results when coordinated with National Weather Service data will be of value to the Ice Navigation Center. A model study of the St. Marys River and an investigation into winter navigation for the St. Clair-Detroit Rivers are under analysis by the Ice Management Work Group.

A rather difficult problem caused directly by extending navigation has received considerable attention. Ice bridges that are something like ice booms but which form (and break up) naturally permit navigation, or transportation across them, to and from inhabited islands in the St. Marys River. Residents are dependent on the bridges for access to schools and businesses. When they are broken for conventional navigation ice builds up in slips and normal routes, effectively halting island ferry traffic. The problem has been solved to the satisfaction of most by providing alternate means of transportation such as an air boat, giving Coast



Scientists from the U.S. Army Cold Regions Research and Engineering Laboratory conduct ice force tests in special cold room (above); U.S. Coast Guard tests davit-launched liferaft with 25 seamen aboard, as possible replacement for present system of dropping rafts over board before crew abandons ship.

Ice boom installed between Ogdensburg, N.Y. and Prescott, Ontario, by St. Lawrence Seaway Development Corporation; gate at upper left of photo (above) permits ships to transit while maintaining integrity of ice cover; corps of Engineers bubbler system succeeded in causing ice hole in St. Marys River.



Guard ice-breaking assistance to ferries, and installing special equipment in slips that reduces ice buildup and flushes floating ice.

The Economic Evaluation Work Group, also headed by the Corps of Engineers, must answer the question; is it, or will it be, worth all the effort? To the simple comparison of additional tonnage carried-vs-the cost of the experiments must be added the answers to many interrelated questions. For example, how much does it cost to unload a ton of iron ore under normal conditions and under severe winter conditions? What effect will the program have on employment and on Great Lakes industry? Are Demonstration Program costs fixed or variable?

The Group obtains and carefully analyzes costs of projects by other Work Groups, and adds such factors as higher insurance rates, damages to vessels, and equipment maintenance. On the credit side of the ledger are such items as greater volumes carried, reduced stockpiling, and the stabilization of traffic patterns and routes. This Group's reports will form the primary base which Congress will use to determine the future of extended, if not year-round navigation on the Great Lakes.

The Environmental Evaluation Work Group, headed by the Environmental Protection Agency, is the other group with participation by NOAA's Lake Survey Center. This Group's responsibility is to evaluate the various Demonstration Program projects and to determine the environmental impact of each. Group members work essentially in their areas of expertise. For example, the Bureau of Sports Fisheries and Wildlife is concerned with the effects on wildlife habitats, winter fishing and on wildfowl feeding areas. Other areas include the effect of ice-breaking on shore structures, on winter recreation activities and on local meteorological conditions. No adverse effect was observed from operating the Lime Island bubbler system. In fact, the introduction of oxygen was considered a plus. On the other hand ice breaking and navigation did interfere with St. Marys River island ferry systems. Final results of this Group's effort will have a significant effect on the program's future.

At this point the agencies involved in the Winter Navigation Demonstration program are optimistic about the practicability extending the shipping season. However, they are also aware that winters have been on the mild side so far, a factor that unquestionably contributed to early success. These conditions, too, permitted the perfecting of equipment and procedures. The various groups are probably better able to cope with a really rugged winter now than they would have been in the beginning. But what about "year-round" navigation on the Lakes-Seaway system? That is the question that cannot be answered. The two-year extension of the project should provide the additional knowledge needed to answer that question. □

In a vault at Riverdale, Md., The National Ocean Survey stores

FIFTY THOUSAND FEET OF HISTORY

BY EARL RAYFIELD*

It is known simply as "The Vault." Few in NOAA are acquainted with its existence, but within its confines are documents which it has been estimated could cost almost a quarter billion dollars to replace.

The great and the near-great have come to the vault to view some of its unique documents—a Chief Justice of the United States, a Speaker of the U.S. House of Representatives, high officials of the executive departments.

Like the Library of Congress and the National Archives, the vault holds documents which mirror in texts, drawings and photos an important chunk of American history. It is one of the nation's most important repositories of historical documents. Many of its historical documents play an important role in everyday life.

These are primarily records of hydrographic and coastal topographic surveys which are still as pertinent today as they were when they were made scores of years ago. Some date back to 1834.

NOAA's National Ocean Survey, which has jurisdiction over the vault, has estimated that if the surveys had to be done over again, it would cost $220,000,000. This was the estimate furnished the General Services Administration, the government's housekeeper, in 1970, when it sought to determine the "regeneration costs" of these valuable documents.

In the vault, located in Riverdale, Md., are 19,000 survey sheets and 17,000 descriptive reports filed by the surveyors with their survey data, all originals, and two million units of geophysical data, including data on magnetics, gravity and seismic reflection profiling. Also in the vault is a considerable variety of original documents other than these which have been used by writers to describe the exploits of armies, navies and pioneers; drawings showing the location of famous battles, of Civil War emplacements and forts, and George Washington's birthplace in

**Earl Rayfield is Chief, Operational Support Branch, NOS Office of Fleet Operations.*

Crewman of the Coast and Geodetic Survey Ship SIGSBEE demonstrate deep sounding machine, forerunner of the fathometer (1895).

Wakefield, Va; correspondence between U.S. foreign notables in boundary disputes; century-old photographs of land configurations before and after earthquakes, of field parties of the past and their surveying instruments; of prominent landmarks and of sundry other objects, all considered relevant to surveys by the engineers who performed them, including a century-old drawing of a sea cow and fur seals sunning themselves along a Siberian shore.

New material is constantly being added, including, in more recent years, the results of aerial photographic surveys of the nation's coastlines.

Many of the early surveys came embellished with drawings, photos and descriptive text and since they are originals, they provide documentary proof required by law to substantiate land and property claims. Many of the survey documents were prepared by engineers of the Survey of the Coast, established under President Jefferson in 1807, and subsequently renamed the Coast Survey and the Coast and Geodetic Survey. Their work is now carried on by their successor, NOAA's National Ocean Survey.

The vault takes care of some 3,000 requests each year from the Departments of Justice and Defense, state governments, universities, exploration firms, historians and the men who make nautical charts for the federal government. Justice Department attorneys avail themselves frequently of the vault's services, using the information from the records in litigation involving claims to which the federal government is a party. Several recent ones involved disputes in Louisiana and New Jersey over the location and extent of wetlands. Since coastlines have changed over the years, the survey documents provide proof of the lay of the land at a given point in time. The photos and drawings and the descriptive material furnished important substantiation.

Correspondence in the vault's files provide interesting insights on important historic events in the life of the nation of which cannot be found in most history books.

Did you know, for example, that Canada "invaded" the United States in 1887? The Canadian officials didn't know they were invading in Lake Huron when they pounced on the fishing net of S.F. Tolsma, of Detroit, Mich. They thought the net was in Canadian waters.

The incident resulted in an acrimonious dispute between the two nations. Americans and Canadians take for granted the undefended almost 4000-mile common boundary, but there were times when things were not that peaceful.

It appears, according to the documents on file in the vault, that during the 1880's there had been a running dispute between U.S. fishermen and the Canadian fishing authorities over fishing rights and the Tolsma incident brought things to a head. "United States fishermen have suffered much from the arbitrary manner of Canadian Government officials," wrote the U.S. Deputy Collector of Customs in Michigan. "There seems to be no limit to what some Canadian officials can do with United States fishermen."

He added pointedly: "If this matter is conducted another year as in the past, it may lead to violence." Disputes over fishing rights have often resulted in war, as witness the recent "Cod War" between Iceland and Great Britain.

Tolsma filed a formal complaint in which he declared that on June 11, 1887 "John Marks, one of the Canadian Governmen: officials holding the offices of Deputy Canadian Fishery Overseer and Deputy Collector of Canadian Customs located at St. Joseph's Island, Ont., did willfully on the above mentioned date take and raise my Pound Net out of American waters and with a force of men and steam tug take and carry away my net to the Canadian side and I have not seen my Net since." He asked $20,000 in damages.

The Department of State and the Privy Council of Canada entered the fray and the correspondence went back and forth, waxing hotter as the exchanges continued. The Privy Council had a survey made of the water boundary and advised the Department of State that the survey showed that while a portion of the seized fishing net "may have been" in U.S. waters, that part of the net which caught and held the fish "was clearly in Canadian waters" and Tolsma had no license for his net, therefore, it was subject to seizure. The Privy Council rejected his claim and so informed the British Secretary of State for the Colonies in London and the British Ambassador to the United States, as well as the Department of State.

The Secretary of State called upon the Secretary of the Treasury to have the Coast and Geodetic Survey, then under his jurisdiction, make a survey of the boundary near Burnt Island, Mich., where the incident took place. The Secretary of State stressed that "an important question" was involved "of the probable invasion of the jurisdictional waters of the United States."

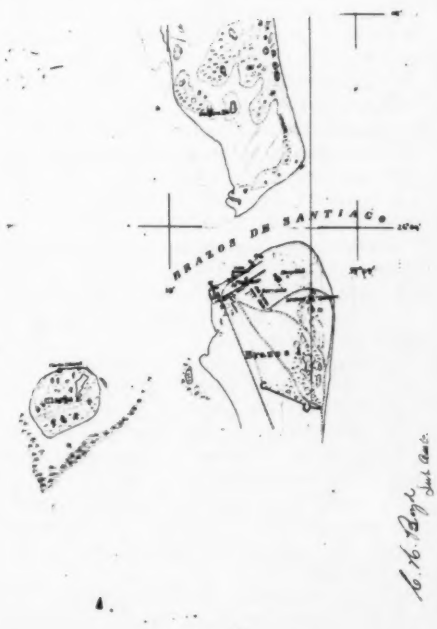
The survey by the Coast and Geodetic Survey revealed that the Canadians had not only invaded the United States, but that their 1888 version of the boundary charted in 1835 "had meandered sufficient to claim a little more territory and particularly a portion of Mr. Tolsma's net."

The documents in the vault do not reveal the outcome of Tolsma's claim, but apparently the dispute between the two nations was resolved peacefully. There is no record of a "fishing war" in 1888 between the United States and Canada.

For the past 80 years the contents of the vault have been zealously guarded by two supervisors—the present supervisor, Benjamin Johnson, who has served there for 38 years, and his precedessor, the late Edward Jenkins, 44 years.

Visitors include all manner of government

The late Edward Jenkins, Supervisor of the Vault from 1918-1962, retrieves a hydrographic survey sheet.



An 1862 pen sketch, part of the survey of Brazos Island (Texas) Fort, that was requested by Sam Rayburn.

personnel, including major elected and appointed officials, and historians, all sharing the common dilemma of not being able to delegate the viewing of an historical document to someone else. Unless the caller knows precisely what he wants, the document must be researched at the vault. Furthermore, original documents cannot be removed, except by the chart makers who use them to make comparisons with more recent hydrographic information.

Jenkins took care of many dignitaries, but the story he relished best was the one he called, "The day Mr. Sam came early."

Sometime in 1955, Jenkins was alone in the vault when he received a phone call from someone above who said: "We've just gotten word that the Speaker of the House, the Honorable Sam Rayburn, is coming to visit the vault tomorrow. We don't know why he's doing this, but we want you to be prepared. He will probably be accompanied by the Secretary of Commerce and we'll have some people there also just to answer questions and to show him whatever he wants to see, but you be available just in case."

Then the as-yet-unidentified caller added: "And by the way, wear a necktie tomorrow."

Jenkins replied, almost apologetically, "I always wear a tie."

"Well, that's fine," replied the caller, "be sure to wear one tomorrow. And by the way, check to see that the vault is cleaned."

"The vault is cleaned every day."

"That's fine, just fine. Stay cool and if you have any questions, just give me a call. We don't know yet what time the Speaker will be here tomorrow or just what he's looking for, but we're making extensive plans now to be ready for him. Oh, and by the way, tell your assistant to wear a tie tomorrow also. In the meantime, keep calm and call me if anything comes up, anything at all."

And with that the caller, still unidentified, hung up.

Jenkins left the phone pondering over who was talking to him and somewhat miffed that they would send someone to assist the Speaker since Jenkins had spent more than 30 years working in the vault.

There was the time, he recalled, when Chief Justice Fred N. Vinson had visited the vault and was so pleased with the service he received that he had sent Jenkins a letter of appreciation.

Jenkins had no sooner mulled this over in his mind than the bell at the day cage door signalled the presence of a customer. When Jenkins opened the door he observed a short rotund man, with a shiny, bald pate and a pleasant manner.

"I would like," said the stocky individual, "to see a particular survey of southeast Texas. My secretary telephoned I was coming over and . . ."

"That's all right sir," said Jenkins, "no appointment is necessary. We're here from 8 to 5, five days a week, and we're here to serve your needs."

"Fine," said the customer, "I'm interested in a survey done by a Mr. Burke who did surveys all over Texas and was an old friend of my family, the one he did of the Brazos area of Texas about a hundred years ago. It shows a fort on it and it's of particular interest to me."

"You just look at the index," said Jenkins, "show me the area of your interest and the date and I'll have the survey down here before you can say Sam Rayburn."

The customer smiled broadly, and remarked: "You know, at first I thought you didn't know me."

Mr. Sam, like the Chief Justice, sent a letter of appreciation for the fine treatment and excellent service he received at the vault in being able to secure a print of the survey which he framed and gave to a close friend to mark a special occasion.

The vault has been located at various places since the establishment of the Survey of the Coast in 1807. In time, the Coast and Geodetic Survey set up a "survey room" to

OAKLAND ENQUIRER. 1768

VOLUME XXIII. OAKLAND, CALIFORNIA, MONDAY EVENING, JULY 3, 1893. NUMBER 2.

BIRD'S EYE VIEW OF OAKLAND AND ENVIRONS.

GREAT TERMINAL FACILITIES

Ready For Important Railroad Developments in Oakland.

A Year's Operations By F. M. Smith and Co-Operating Syndicates.

The Reason Why Vast Purchases of Real Estate Have Recently Taken Place.

A New Ferry System With Connecting Railroads Which May Become the Terminus of a Transcontinental Road.

Back in the days when life was rougher and readier, this portion of Page One of the July 2, 1893, Oakland, Calif., Enquirer was filed as descriptive report with survey data.

accommodate the original survey documents, with an eye to preserving them.

The early surveyors recognized the need for supplementing their measurements with a narrative. The texts were recognized as being so valuable that soon the "Descriptive Report" was required as an integral part of each hydrographic and topographic survey.

By 1880, some reports had become elaborate. The early descriptive reports, regardless of size or content, were intended to augment the survey report in the most comprehensive manner, no matter how informal. In 1893, for example, extensive surveying was performed in the Oakland Bay, Calif., area to support an expansion of port and rail facilities in anticipation of a developmental boom.

The descriptive report submitted by the chief of party upon the completion of the surveys consisted entirely of the July 3, 1893 edition of the Oakland Enquirer which contained a lengthy article on the bay areas' land use program. The chief apparently thought that was sufficient. The newspaper is faded and yellow, but it has been kept to this day as part of the survey report.

A descriptive report submitted in 1907 by another chief of party makes it evident that even then oil pollution was a problem. He reported that in the Port of San Luis, Calif., whose principal business was the shipment of oil, both crude and refined, "carelessness in handling the oil has resulted in making Port San Luis the vilest, dirtiest place that I have seen on the coast. Oil covers every thing . . . the piles of the dock, mooring buoys, . . . as well as all boats unfortunate enough to be obligated to navigate the waters of the bay are filled with it."

An 1876 report also had a familiar ring to it. In response to a request for assistance in surveying a disputed Virginia-Maryland boundary, the Coast Survey stated that it would "cheerfully" help "if the Boundary Commission will pay the general expenses." The agency emphasized: "The Coast Survey has, at the present time, no funds which can be diverted to that purpose." Subsequently, an officer detailed for the task was advised by Superintendent C. P. Patterson that the commission would pay his expenses and the Superintendent then stressed that "the Coast Survey has no funds whatever to advance for the work."

Before the days of photography, illustrations furnished with the report were often pen drawings, some very detailed and artistic as were 1889 sketches of Chatham Wharf, Stateg Harbor, Mass., and a tide gauge at Dennisport, Mass., drawn by B. V. Sinclair, a seaman. The illustrations were painstakingly drawn, usually at night, by the light cast by an oil lamp in the tent which served as the surveyors' field home.

Detail from 1899 drawing of tide gauge at Chatham, Massachusetts.

"Store of S.S. Baker" at Dennisport, Mass., was feature of tide gauge sketch in 1889.

The Survey Room experienced a slow but steady growth during the first 50 years with the descriptive reports being placed within envelopes and filed in cabinets, while the survey sheets were housed in metal canisters that stood end on end.

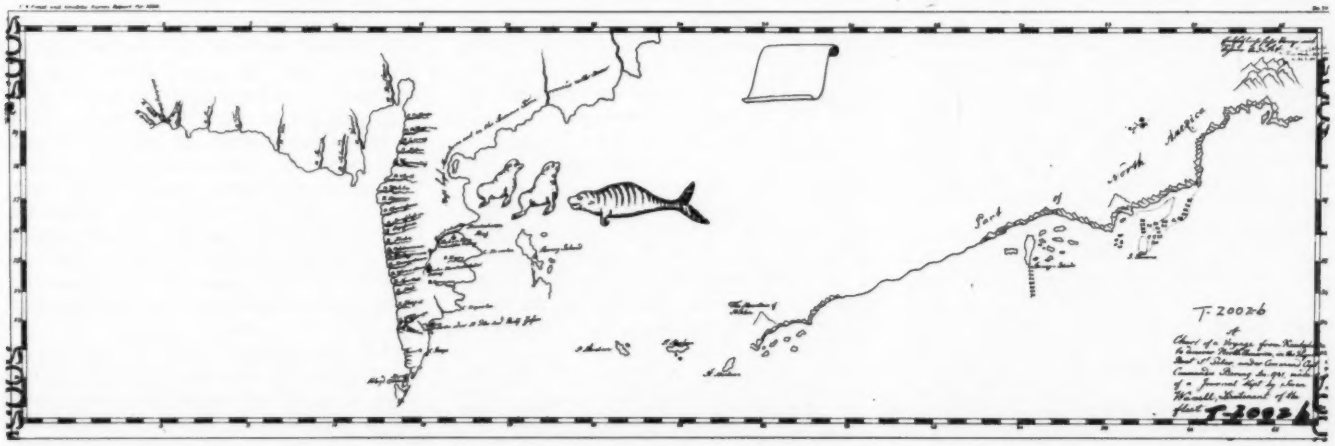
By the start of World War I, the Coast and Geodetic Survey had moved to quarters on lower New Jersey Avenue in Washington, D.C. There in the Survey Room a cubical network was installed at a cost of $7,990 which, oddly enough, was just $10 less than the cost of its replacement in 1969. The network ran from floor to ceiling, had 4 inch by 4 inch apertures and afforded horizontal storage of canisters.

When the agency moved to the newly-constructed Department of Commerce building, a room was built 60 feet long by 20 feet wide by 14 feet high. It was equipped with steel doors six inches thick, complete with four-position tumbler, lockable day cage doors and a ring-for-service bell. The configuration was in keeping with safe deposit rooms found in large banks of the era, promoting the term "vault" as the appropriate name for the repository and bringing to an end all the prior informal names, such as Library, Survey Room and even Attic.

In 1969, the vault outgrew its quarters in the Commerce Building and was temporarily housed in the old National Bureau of Standards Building at Connecticut and Van Ness Avenues. About a year ago, it was moved to Riverdale, Md., where the National Ocean Survey's distribution facilities are located.

There it occupies 50,000 cubic feet of storage space and here may be found the vital records, old and new, which provide the basis for the maps and nautical charts without which much of the national economy could not function.

Yellowed with time, musty and sometimes wrinkled, the original documents, some almost a century and a half old, have a personality of their own, providing unique portrayals of a given spot on earth at a given point in time. □



Part of an 1890 Survey report based on drawing by Bering Expedition from Siberia which discovered Aleutians in 1741. Sketch contains a "manati or sea cow", along with two seals, and was said then to be only existing portrait of the manati.

Sea Grant advisors and foreign buyers are making possible

THE BIRTH OF A FISHERY

BY MARC SHULMAN* and ROLAND PAINE

They say that there are still places in the midwest where you can of an evening crunch a Blind Robin with your brew. They say that in bars and taverns well away from the freeway, in places like Manitowoc, Wisconsin, and St. Cloud, Minnesota, and Rockford, Illinois, a man can still join his friends in camaraderie and enjoy the smokey snack right out of the little package hanging on a peg by the bar. Time was when these gustatorial delights in cellophane wrappers were available as far east as Tyson's country store in Fairfax County, Virginia. But that was before the bulldozers wiped the little store, and the crossroads, right off the landscape.

Nobody ever paid much attention to what Blind Robins really were, except presumably the people who packaged them for sale. If they thought about them at all, people probably thought they were sardines or some other relatively familiar-sounding little fish. Actually, Blind Robins are simply strips of smoked eel. Eel is a fish seldom eaten in the United States, but known and appreciated in Scandinavia, eastern Europe, Germany, Italy, Japan, and England, where the term blind robin apparently originated.

Because eels never caught on as a seafood in the United States, other than in a few places where people from the Old Country remembered and were able to obtain them, the long, snake-like fish have seldom been sought by fishermen here. Usually those caught by accident have been discarded, or cut up for bait. Today, however, foreign countries are coming more and more to look to our streams and rivers for sources of supply, and a domestic market is beginning to open up.

Down in North Carolina the common American Eel is found in great numbers in the fresh water streams and the estuaries. A Sea Grant team under Norman Angel, Director of Marine Engineering Advisory Services, North Carolina State University, at New Bern has worked out an active program to advise fishermen on the best ways to catch and hold the animals. They have worked with food processors and with foreign buyers to increase the marketing possibilities (they shipped their first live shipment of eels to Japan just before Thanksgiving), and on a Sea Grant exchange with the Virginia Institute of Marine Sciences they have learned more about fyke net design.

Theodore Rice at the Beaufort Laboratory of the National Marine Fisheries Service has been closely involved in their work, too. "We're a long way from the university, so we use his library," says Angel, "and we pick his brains for many ideas. That lab has been a great help to us."

The object of all this activity is a fish, usually without scales or pelvic fins, that in its American forms averages about three feet in length, with a maximum of about four feet. The European Eel is somewhat larger, sometimes attaining a length of five feet and weight of 20 pounds. Only in Central America does the American eel grow larger, sometimes measuring 10 feet in length.

Most people have heard of the electric eel—which can discharge as much as 650 volts of electricity—and the moray eel. These, however, are of an entirely different family and are not sought for food. Like all eels, the American eel is catadromous —an unusual characteristic meaning that

* *Marc Shulman is Assistant Program Analyst, Office of Sea Grant*

Aquaculture ponds for eels at Yoshida-Machi, Japan, a nation where fresh eels are a prized seafood item.

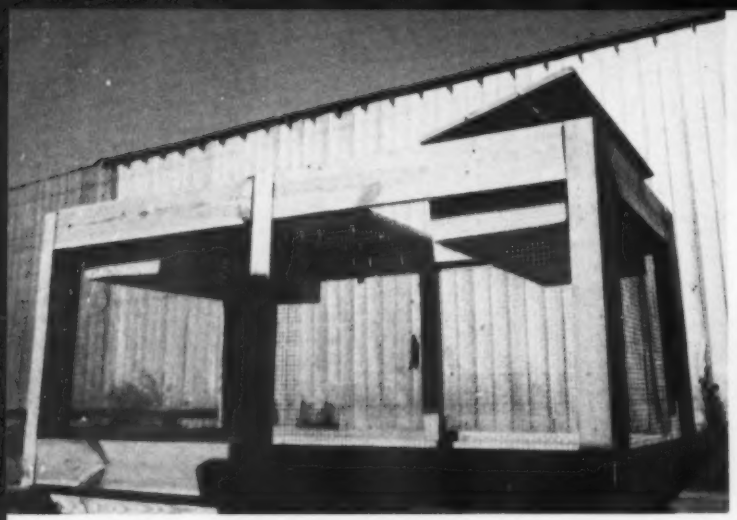
it lives in fresh water or estuaries, but moves to salt water to spawn. The exact life history of the eel is still debated among scientists, but it is generally believed that the mature eel spawns at great depths in the Sargasso Sea. The eel that is chiefly of commercial interest in North Carolina is called the "silver eel." Silver eels are one form of the common American eel—mature, roe-bearing females whose stomachs have disintegrated and who have turned from brown-black or yellowish to silver-gray in color. These mature female eels move down the rivers in the late summer and early fall to begin their journey to the breeding area. This journey may take up to a year. During this period they do not stop to feed, and therefore cannot be caught in baited traps —hence the work with fyke nets.

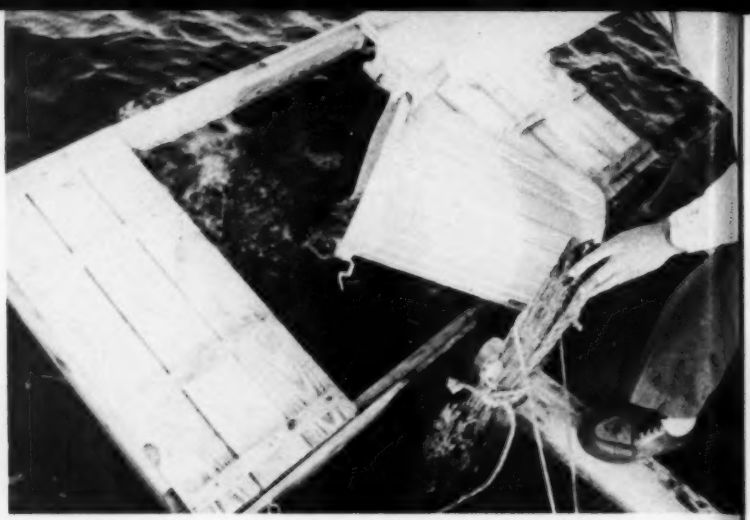
The female eel can produce from three to ten million eggs during spawning, and dies shortly thereafter. From the time of spawning, some scientists estimate that it takes approximately a year for the young eels—called elvers—to return to United States continental waters. They move into bays and inlets, and in late spring great numbers of them begin their journey upstream. The males apparently stay in brackish water, while the females travel much greater distances, and live and grow in fresh water for long periods—5 to 20 years—before returning to the sea to spawn.

The eel fishery in North Carolina is growing steadily, and Angel estmates that up to 50 fishermen in Albemarle Sound, along the northern sector of the state, now fish for eels during the season. As a sign of the expanding market, he points out that local fishermen a year ago received 21–25¢ per pound for eels, while today the price is 50¢ per pound.

Eel fishing is possible year round, and the eels feed on nearly any species predominate at the time. In North Carolina, Angel notes, eels travel far up the fresh water streams during herring and shad spawning seasons, in search of the roe. Knowledge of the spawning seasons of other fish is important to the eel fisherman, he says, because the species running at any given time is the best eel bait. Crab scraps and shrimp heads, usually available free in large quantities from processing plants, are also good bait, provided they are fresh. Eels are both predators and scavengers, but are attracted primarily to freshly killed food.

Walter Jones, Arthur Chleborowitz, and Gene Crow are the trio at New Bern, in N.C. State's Industrial Extension Service Marine Science Program, who work with Angel on development of the eel fishery.





North Carolina eel fishery, showing (top photos) eel car or holding box capable of holding 1500 lbs. of eels; standard eel pots in wide use (bottom photos).

Among their activities is the development of experimental models of traps for catching eels. The trap in common use consists of a mesh wire cylinder with an entrance made of cloth at one end and an interior funnel, of nearly the same configuration, inserted approximately half way through the cylinder. The interior funnel separates the trap into two compartments, and a cloth tail bag closed with draw strings is attached to the other end. It is untied to remove the trapped eels and replenish the bait supply in the rear compartment.

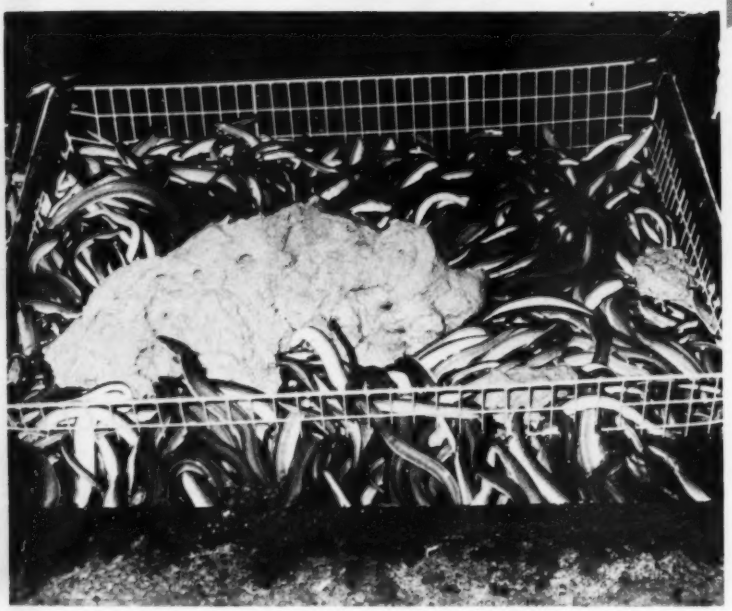
Traps must be worked frequently—every six to eight hours—because the eels are relatively aggressive about taking care of themselves when trapped. After they have eaten the bait they start looking for a way out of the trap, and will find a way or tear a hole in it to escape.

Among the activities of the Sea Grant team in developing the fishery have been informal meetings and demonstrations to inform fishermen of the eel market and to advise them of methods and techniques of eel harvesting. Angel has appeared on television three times on stations along the Carolina coast, and newspapers have covered their work. As the demand for eel traps has increasesd (each fisherman may use as many as 150), a beneficial side effort developed. Angel contacted a local workshop for the handicapped and disadvantaged, which soon developed a trap production capability of 200 traps per week following instruction by the marine advisory staff. The traps sell for $3.50, giving the workshop a profit of 75¢ per trap.

Eels have a delicate flavor, Angel points out, and European buyers have developed strict requirements for shipment of frozen eels to ensure their high quality. To meet these requirements, marketing agreements provide that eels are alive when delivered to the processing/freezing plant. Newly caught eels are placed in holding tanks for 5 days, so that their digestive systems are completely purged. These holding tanks may be submerged in river water, but sometimes are more substantial on-shore facilities with circulating water and an aeration pump. To help develop the eel fishing activity, the marine advisory team had three 1,000 gallon concrete tanks constructed and a water circulation system installed, in which eels can be held for up to 30 days with only a slight weight loss.

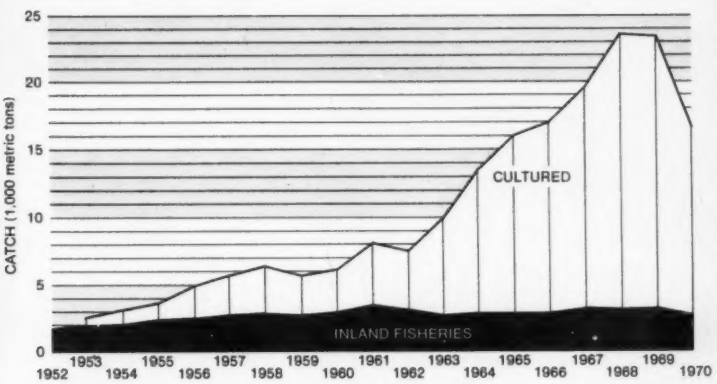
After purging, the live eels are transported to the processing plant where they are graded by weight, packaged in 25 pound boxes, and quick-frozen at 40° below zero. The frozen eels are shipped in 15,000-pound lots to European markets from Norfolk, Va. Angel estimates that about 250,000 pounds of North Carolina eels were exported during 1973.

The eel project at New Bern has not only received support from NOAA's Office of Sea Grant and from North Carolina State University, but has had the participation and cooperation of numerous state and community groups and of private industry. Among them has been the North Carolina Council of Churches, which is in the process of establishing a freezer plant at its Fairfield Migrant Labor Project (East Carolina Industries), for the purpose of freezing and marketing eels. The marine



Major Japanese eel fishery and eel research laboratory are located in Shizuoka Prefecture.

Photos at left show eels feeding in culture ponds at Yoshida-Machi, Japan, and technicians sorting eel catch. Below, chart shows importance of Japanese eel fishery.



advisory staff has been providing technical guidance for the project.

While Angel and the North Carolina group are helping develop the adult eel fishery, elsewhere in the southeast there has emerged the possibility of utilizing the young eels—the elvers—in commercial ventures. This arises from a combination of factors affecting the Japanese adult eel market, including rising personal income in Japan that strengthened the demand for eels while increased fishing pressure and environmental factors decreased the supply. The Japanese began to culture eels to supplement the supply of wild and imported eels, but these efforts have been limited by the availability of elvers. Hence the Japanese have begun seriously looking into obtaining supplies of American elvers.

Dr. Evan Brown, an economist at the University of Georgia, recently acted as host to a team of Japanese eel experts visiting the United States to study these possibilities. Unlike European buyers, the Japanese want live eels. Elver investigations were conducted by the Florida Department of Natural Resources and industry representatives in North Carolina, with assistance and coordination by staff of the National Marine Fisheries Service.

Various types of nets and gear were tested in efforts to capture the elvers. Because at one stage elvers are virtually transparent they are sometimes called "glass eels." Some 3,000–3,700 individual "glass eels" are required to make one pound. Quantities caught in these tests were not sufficient for commercial purposes, but the Japanese visitors were sufficiently encouraged to feel that further work would be warranted. In another area larger elvers, averaging about 50 to a pound, were fished. Several pounds of elvers were taken and shipped to Japan.

Subsequent to the exploratory efforts on the St. Johns River in Florida, the Japanese attempted to capture elvers from the Suwanee River in Florida and the Neuse River in North Carolina, but were unsuccessful.

The Japanese team visited Angel's group at North Carolina State University during their trip to the United States, and tested the eels in that area, including charcoal broiling an eel. "They are looking for eels of high oil content," Angel noted, "because they smoke better than do dry fish." The Japanese prefer medium-sized eels of about four ounces up to a pound, he notes, while Germans will take them anywhere up to five pounds. In addition to charcoal broiling and smoking, he says, common ways to prepare eels are baking or broiling with onions.

Angel's group is also working with the N. C. State Department of Food Science, East Carolina University's Regional Development Institute, and state agencies to increase the American market for eels. "Demand has always been good in some parts of the country at Christmastime," he says, "especially in New York where eels have formed part of traditional holiday fare brought over from other countries. We are working to introduce smoked eels to the American market in all seasons."

If they are successful, maybe a man with a thirst will again be able to find a Blind Robin in Fairfax County, Virginia. □

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They Called It FACE '73

CUMULUS CHASE OVER FLORIDA

BY CONSTANCE A. ARNHOLS*

"This NOAA Four-one . . . EML Control, do you read me?"

This staccato air-to-ground radio query soon became a familiar signal to members of the Experimental Meteorology Laboratory early last summer when the Florida Area Cumulus Experiment was launched to probe cumuli over a 4800-square-mile target area northwest of Miami. Experimental flights, made to determine the effect of cloud seeding on areal rainfall over south Florida, began with the airborne project director aiming his question at EML's radar monitors on the ground.

NOAA's C–130 and its companion DC–6, flying missions every day that weather conditions permitted, represented the hopes and participation of seven NOAA units, the University of Virginia's Department of Environmental Sciences, the University of Miami's Division of Atmospheric Sciences, the National Hurricane Center, and the Atmospheric Physics Branch of the Naval Research Laboratory. These groups worked together from June 11 to September 12 to carry out a core program consisting of randomized, dynamic cumulus seeding and a schedule of 14 related subprograms. The subprograms were concerned with rainfall measurement via a ground network of gages, as well as movements of the Florida sea breeze, cloud base measurements, raindrop size, the structure of the boundary layer, radar measurements of rainfall, cloud photography and satellite coverage.

The core program, for which the Experimental Meteorology Laboratory was responsible, was directed by EML's Dr. William L. Woodley in conjunction with the laboratory Director, Dr. Joanne Simpson. Before the first artificially induced raindrop could fall and the core program begin, an awesome array of personnel and equipment had to be marshalled for data collection and later evaluation. A first step was the arrangement of a 250-square-mile surface gage network just south of Lake Okeechobee, near Clewiston, Florida. Under the direction of Dr. Michael Garstang of the University of Virginia, 229 raingages were set out one mile apart, with an additional five clusters of recording gages (a total of 40 gages) each placed on the periphery of the Garstang network. Also in the Garstang network area were anemometers, thermographs, radiosonde equipment and photography sites.

With the gage network set up and the Research Flight Facility staff on standby alert with two aircraft, EML was ready for its daily FACE routine. The FACE day started with a computer run of the laboratory's one-dimensional cumulus model on the 8 a.m. Miami Airport radiosonde for three cloud base heights and a hierarchy of five cloud tower radii for each base. A second sounding was called in (from an area within the network dubbed "Central Site") before 10 a.m. and the model output was usually available shortly afterward. If the model run and the EML radar scans of the south Florida peninsula cloud development indicated that atmospheric conditions were right, EML meteorologists pronounced it a GO day and took off in the C–130 for seeding runs. The DC–6 group flew for cloud base measurements, with takeoff frequently one to two hours before the C–130. A typical C–130 flight lasted about six hours on a day in which conditions remained on a GO status. Scientists and flight crew often emerged from their aircraft feeling like so many dice tumbling from a windblown canister. Frequently, cameras were torn from photographers' hands, coffee pots remained suspended from the plane's ceiling for seemingly long moments and G forces reached crushing acceleration in the sudden updrafts and downdrafts. Updrafts sometimes carried the C–130 aircraft upward at a rate near 50 miles per hour. When a daily challenge such as this is met without weekend or holiday respite over a three-month period, those who pursue cumuli come to know the limits of human endurance.

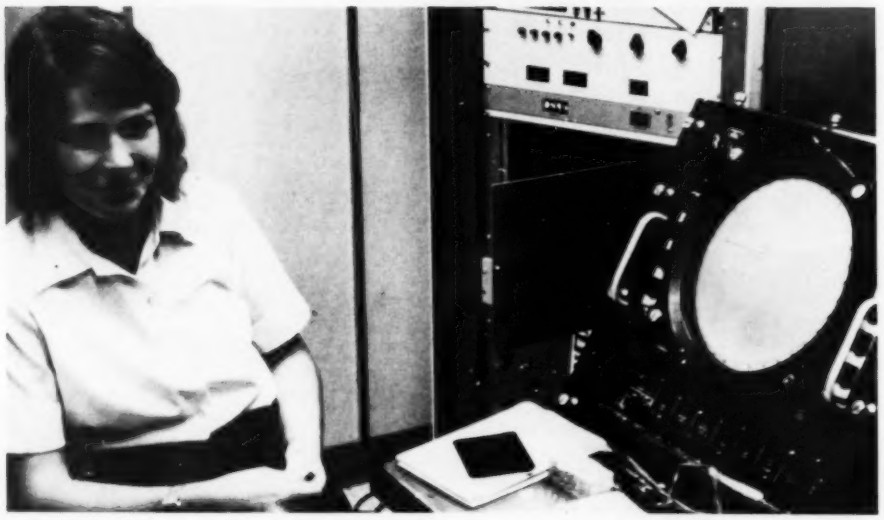
When weather changes would call for cancellation of seeding studies in mid-flight, project scientists resisted grounding for the day and continued work on the various subprograms while airborne so as not to lose precious flying hours. Or, if an aircraft ran into malfunction problems, there would follow a switch from seeder plane to light aircraft for non-random control studies.

Aboard the C–130, EML meteorologists were purposely kept unaware of whether their silver iodide flares (seeding agents) were actually being emitted into target clouds when the flare release button was pushed. This rule was made to eliminate even subconscious bias in the calculation of rain volume from any one cloud system. The seed-no seed decisions were made prior to the start of FACE by the EML statistician who was instructed to prepare a series of cards on which the decisions were written. Only the technician who armed the flares and of course, the statistician, knew on a given day whether seeding would actually occur. The decisions are to be revealed only at the conclusion of the analysis of project data.

While airborne, the Project Director maintained continuous radio contact with EML Control, the team monitoring cloud conditions and locations over south Florida on a WSR–57 radar scope.

Flight intentions were, at the same time, received by the EML Mobile Unit, waiting at Central Site in the Garstang network. A truck that carried personnel over rough dirt roads into the heart of the target area enabled a special rainwater collection system to be maintained. By radio communi-

* *Constance A. Arnhols is a writer-editor at the Experimental Meteorology Laboratory, Coral Gables, Florida.*



Above, Dr. Joanne Simpson, Director of the Experimental Meteorology Laboratory, reports position of seeder plane to EML Control. At right, Doppler radar atop a trailerized laboratory on Lake Okeechobee's dike. Below, Cecelia Griffith at the WSR-57 radarscope at the EML Control headquarters.

cation with the seeder plane, the Mobile Unit was guided to areas below experimental clouds and obtained as many as 10–12 samples of rain water from a single GO cloud. This was the first time EML had attempted to pursue a moving target, since the problems of keeping up with a GO cloud and then storing water samples had seemed insurmountable to many experts. As it happened, over 50 Mobile Unit samples were obtained. All were promptly frozen in a cooler with dry ice and later stored in a freezer. They are to be analyzed for silver iodide content by an atomic absorption method. Preliminary results of analysis of the ground water samples show that silver iodide concentrations in seeded rainfall are below those concentrations regarded as unsafe by U.S. health authorities.

Among other subprograms that were organized to provide crucial information for future cumulus cloud studies was a small network consisting of ten mechanical weather stations placed in remote areas of the Everglades. Contributing to the small network project were cooperative observers located throughout south Florida, and regular reporting stations such as those maintained by the National Weather Service, the Federal Aviation Administration, the Air Weather Service, the Navy and the Coast Guard. This surface data from the south Florida peninsula will aid in the understanding of thunderstorms and their relation to the sea breeze and boundary layer structure.

In still another subprogram, the C–130 doubled as both a seeder and an observatory for the investigation of the dynamics and microphysics of cumuli. Scientists from the National Hurricane Research Laboratory, and a cloud physicist from EML, equipped this aircraft for measurement of the water-ice budget of seeded and unseeded cumuli. A DC–6 was flown near cloud base in coordination with the higher flying C–130 to obtain cloud scale measurements for natural and seeded clouds.

One of the most important measurements at cloud base was that of raindrop size from seeded versus unseeded clouds. If dynamic seeding greatly increases the relative number of large drops, a major adjustment must be made in EML rainfall comparison methods, which currently assume no change in drop size between seeded and unseeded precipitation. For a few weeks during the summer, the Atmospheric Physics Branch of the Naval Research Laboratory, using an S–2D aircraft, supported the FACE drop size studies by recording drop impressions on a foil impactor near the bases of experimental clouds.

Using the DC–6, EML in cooperation with the Boundary Layer Dynamics Group made detailed studies of cumuli interactions. with the boundary layer—i.e. fluxes of heat, moisture and momentum through cloud base. An important goal on the DC–6 was to study larger scale phenomena related to cloud merger, cloud-boundary layer interaction and the sea breeze scale of motion over south Florida.

On the ground, dual Doppler radars were situated in the field and operated by a prominent atmospheric scientist from the University of Miami. With these radars, he was able to track cloud particles and thereby wind motions via the Doppler shift principle.

Using two radars, the relative movements of targets toward or away from the radar antenna could be traced in three dimensions. Data was recorded on digital magnetic tape, for which a special playback system is now being developed at the University of Miami. This system will make possible the display and mapping of the signal intensity and radial velocity field. Although the quality and significance of the data cannot be assessed

Dr. William L. Woodley, top left, in radio communication with EML Control from the air-borne C-130 (seen also on Page 50). Below, the takedown of an Everglades weather station. (The canoe was a necessity). Above, a daily reading from remote raingage in FACE array.

until the playback system is completed, the tapes were tested to be sure data was recorded properly.

Airborne photography was used to document cloud size and heights with side-looking and forward-looking time lapse cameras. EML now has a computer program that will combine photogrammetry, knowledge of aircraft attitude and roll, and a grid system to locate the desired portion of each cloud system as needed.

Surface photography consisted of four types. A Hasselblad panoramic made pictures which swept the Central Site horizon every half hour. They were taken so as to overlap one another and give complete coverage of the sky up to a 70° elevation.

Nikon time lapse sequences on 35 mm color film were made once each minute to show detailed cloud structure between panoramic sets. Of special interest are seven sequences showing the development of clouds being studied from seeder aircraft.

Three Bolex cameras were set to take time lapse sequences at three to ten second intervals, mainly from the Doppler radar sites. Finally, slides from hand-held cameras were made to illustrate short-lived phenomena such as tornadoes, funnel clouds and water spouts.

Satellite studies were of particular interest during the FACE project. DAPP (Data Analysis & Processing Program) prints obtained from the Air Force's military satellite, show morning cloud coverage over south Florida prior to seeding. These prints will be correlated with seeded afternoon rainfall areas in the target area. Thus, the relationship of natural cloud cover and resultant seeded rainfall will be ascertained to provide criteria for predictions in future experiments.

One aspect of the satellite studies, which is of great interest to participants in the GARP Atlantic Tropical Experiment (GATE), concerns cloud brightness versus the radar echoes associated with them. Satellite and radar pictures are superimposed to match radar echoes with individual clouds. It is hoped that a correlation between cloud brightness and radar echo intensity can be determined to describe potential cloud behavior. The question of how bright a cloud must be before such a correlation can be established has not yet been resolved.

Although the core program's optimal goal, which was to obtain 20 random GO cases, was not realized due to exceptional raininess in the target area, the minimal goal of seven seed and five control cases was reached. This achievement doubled the cloud experiment data sample that had been gathered during the 1970 and 1971 programs and will give analysts a wide data base from which to make interpretations.

Nineteen days qualified for experiments out of the operation period and 75 days were rejected as unsuitable because they were too wet or too dry. The rainfall measurements in the network seem to support the observations that 1973 rainfall in the FACE area was about twice that of a comparable period in 1971.

Plans for the core program analysis call for emphasis on the evaluation of raingage and radar measurements of precipitation volumes for seeded and control days. Rain measurements in the gage clusters will be compared with rain estimated by the WSR–57 for the same clusters. A daily correction ratio will be made and applied to adjust radar readings. Both unadjusted and corrected radar estimates will be compared with gage measurements to determine whether radar estimates of areal rainfall can be improved by using gages in small and widely scattered areas. Ultimately, this analysis will be a great stride forward in EML's ability to measure modified and natural rainfall. □

By small boat and satellite, marine advisory agents spread the word

NEW BREED ON THE WATERFRONT

BY HOWARD H. ECKLES*

Informal educational actions to help people solve practical problems.

That is one definition of advisory services. And that is what the NOAA Marine Advisory Service is all about. Putting information on the oceans and their resources, on coastal activities, and on marine technology directly into the hands of people who need it to help them earn a living, enjoy the seashore, or manage activities within a coastal area.

In November of 1972, for example, the California Coastal Zone Conservation Act was passed by the voters of the state as a referendum. The resulting Coastal Commission permit procedures and planning caused disorganization and confusion among coastal zone managers and developers of property within 1,000 yards of the mean high tideline. Responding to this massive uncertainty and unrest, the Marine Advisory Service of the University of Southern California drafted and published a chart accompanying text laying out the interim permit procedures, giving both the time factors that would be required for obtaining permits, and a layman's explanation of the Act.

More than 1,000 industrial firms received the document, as well as as an additional 4,500 firms such as banks, communications centers, and shops that were affected by provisions of the Act. It proved to be the most timely and useful explanation available of the interim permit procedures, and was used and distributed by numerous public agencies and by the Los Angeles Region Coastal Commission and the Los Angeles Chamber of Commerce.

Thus, while the need for marine advisory services—sometimes referred to as extension activities—has historically been particularly acute in fisheries, other areas of ocean activity are also increasingly seeking assistance. This growing need for information and education has stemmed from the nation's increasing use of the coastal zone for recreation, industry, residences, transportation and numerous other activities. NOAA's marine advisory services, based upon the Sea Grant charter and the National Marine Fisheries Service responsibilities under the Fish and Wildlife Act of 1956, are designed to meet this need.

Techniques used range from releases through mass media to specially prepared publications and organization of workshops and demonstrations. In Maine, "sea agents" often arise at three in the morning to accompany fishermen on their boats. They observe their nets, and after study, suggest ways to make them operate more efficiently. In Oregon and Texas marine advisory staffs have arranged for special charts to assist fishermen locate fish and avoid bottom snags which damage nets. Advisory services have conducted workshops on marina and boating business management to help solve environmental, operational, and economic problems.

A key to effective marine advisory service is face-to-face contact, such as at this management workshop for professional fishermen in a waterfront cafe.

Where conventional means of communications may be inadequate, imaginative marine advisory personnel will try novel approaches to get their message across. Last August John Ball, Director of the University of Hawaii Sea Grant Advisory Service and representative of the Pacific Sea Grant Advisory Program, arranged for marine extension and resource management specialists from throughout the Central Pacific to "meet" twice via PEACESAT, the communications satellite. Purpose was to develop a list of programs for cooperative work, and the far-flung "assembly" identified aquaculture, acoustic methods of fisheries stock assessment, small boat fisheries, and promotion and management of marine extension programs as most urgent for common efforts.

Even in these conferences of experts spread over thousands of miles, a cardinal rule of marine advisory services was followed—that to be successful, advisory services must depend largely upon personal communications.

When NOAA was formed in 1970 plans were made to include marine advisory services in the new organization. The Commission on Marine Science, Engineering and Resources (Stratton Commission) and a number of other advisory groups had recommended that NOAA establish a system for information transfer as part of its total functions. After policy and organizational responsibilities were decided upon, the NOAA Marine Advisory Service was established in early 1973, with the Office of Sea Grant assigned responsibility for its leadership and coordination. This action took into account the advisory programs that already had been established in most coastal states and in the Great Lakes as part of the National Sea Grant Program.

NOAA major line components have joined the advisory service effort by providing program coordinators, furnishing technical expertise and assisting local advisory projects. The National Marine Fisheries Service was actively engaged in advisory work at the time the NOAA program was established and this contributed significantly to the early strength of the NOAA-wide effort. NMFS supports advisory programs through Public Law 88–309 funds which are administered through state agencies.

**Howard Eckles is Program Manager of the NOAA Marine Advisory Service*

The fundamental element of the NOAA Marine Advisory Service is the local marine advisory program. Typically, such a program is university-based and operates under Sea Grant sponsorship. These local programs serve as the principal point of contact with users. This requires substantial field work whereby advisory and other university personnel meet face-to-face with marine resource users. Local programs are carried out in cooperation with various NOAA components and with experts from other organizations, including federal and state agencies, educational institutions, industry, and local government.

Through the marine advisory network, cooperation is facilitated among people with similar interests in different parts of the country. Early last fall, for example, Dick Beckwith and Capt. Albert Hillier of the Department of Fisheries and Marine Technology of the University of Rhode Island went to the University of Florida, seeking ways to improve New England fishing gear. They were looking for a net design with an opening large enough to catch bottom fish and the higher-swimming butterfish, pollock, and cod. They tested two basic designs, the traditional New England net and a new bottom trawl model designed at URI, in the flume operated by the UF Department of Civil and Coastal Engineering.

Hillier—a veteran of more than 25 years in the fishing industry—used models of net designs made by his students in URI's commercial fishing program. The velocity in the flume was changed to determine at what towing speed the nets performed best.

The research at both universities is sponsored by NOAA's Sea Grant program, and is the beginning of a cooperative exchange program in fisheries between the two universities.

Altogether, there are 30 marine and Great Lakes states that can benefit from marine advisory services. Sea Grant presently supports 26 local advisory programs. Combined with the National Marine Fisheries Service there are 28 local programs in 22 states. Three salt-water coastal states and five Great Lakes states do not yet have marine advisory programs.

Annual funding approximates $3.4 million, including non-federal matching funds. Local program staffing numbers more than 100 fulltime equivalent professional positions.

The program areas that are now of primary concern to marine advisory services are commercial fishing, seafood processing and marketing, coastal zone management, marine recreation and marine science education. Fishery interests receive the greatest effort and it is likely that this will continue. Information needs associated with coastal zone management and marine recreation are growing rapidly. Activities within the NOAA Marine Advisory Service are responding to these needs.

An essential element in successful marine advisory services is feedback—learning from the user what information he needs, then getting the answers and getting them to him. The Virginia Institute of Marine Sciences, for example, has been involved in extension work since its inception in 1940, but did not develop a formal field service until 1970, when a full-time marine extension officer financed by Sea Grant was added to the staff. Personal contact was felt to be the most satisfactory method of providing service, and so the VIMS staff contacted marina operators, charter and head boat captains, fishing pier owners, and local and out-of-state fishermen. There was general agreement that more information was needed on the distribution and seasonality of species of importance to sports fishermen, and VIMS began to work to supply such information.

VIMS has also undertaken several programs aimed at assisting fishermen and the boating industry to adapt to water pollution control measures. Industry workshops have been sponsored on new federal and state regulations governing discharges from boats in Virginia waters, and on the technology of waste treatment or holding systems that is available to the boat operator.

Peter Pownall (left), editor of Australian Fisheries, inspects Oregon fisheries with agent Paul Heikkila and William Wick (right), now head of OSU Sea Grant program.

Robert Taber of the University of Rhode Island's Sea Grant advisory service discusses the introduction of new trawling techniques with local fishermen.

Another marine advisory service: helping the public learn about the importance of the oceans. These children visit Oregon State's Marine Science Center.

Marine Advisory Services on the Air

Two novel, locally-oriented marine advisory efforts are carried on with the cooperation of commercial and educational radio stations in Wisconsin and in California.

The University of Wisconsin Sea Grant program, in conjunction with the Institute for Environmental Studies, tapes a 2-minute "Earthwatch" program five days a week, giving news of environmental problems and attempts to improve the quality of the environment. Subjects range from high water and erosion on the Great Lakes to aquatic weed control methods to recycling used materials. Every weekday 35 commercial stations and 9 educational stations in Wisconsin carry Earthwatch. The program has become so popular that some Wisconsin newspapers carry "Today's Earthwatch topic" listings as a service to their readers, and consideration is being given to expanding Earthwatch into a regional service.

Tapes returned to the university after use are recycled, of course.

In southern California, Los Angeles radio station KNX carries hourly reports on marine recreation conditions every Friday, Saturday, and Sunday, as a marine advisory service of the University of Southern California's Sea Grant program. Every daytime hour all through the weekend the U.S.C. marine advisory staff calls one of 14 harbormasters from San Diego to Ventura to obtain a report of marine recreational conditions in his particular area. This is combined with other reports, including the California Highway Patrol "Sigalerts" that warn of such problems as local high wind conditions inimical to campers, or traffic congestion on coastal highways. U.S.C. then tapes a 30- or 60-second report, pinpointing local conditions of winds, seas visibility, tides, and highway problems, and at 44 minutes after each hour KNX broadcasts the latest taped message to its two million listeners. The report is identified on the news broadcast as "Recreation Watch, a report from the University of Southern California Sea Grant program."

Establishment of the NOAA Marine Advisory Service has provided a significant addition to the previous Sea Grant-sponsored marine advisory services in the form of backup and assistance by other elements within NOAA. Six operating components of NOAA are now cooperating with Sea Grant in the advisory service, and each has named a representative to the Marine Advisory Service steering committee. The recent organization of NOAA's Office of Coastal Environment to lead and coordinate planning for the coastal zone as a result of the Coastal Zone Management Act of 1972 is an important action that will give new opportunities for cooperation among state and Federal organizations in advisory services.

An example of this liaison and cooperation stemmed from a need uncovered by the Texas A&M (TAMU) marine advisory service. TAMU had collected more than 2000 Loran readings from Gulf fishermen, primarily shrimpers, on bottom snags and obstructions that damaged or destroyed their costly gear. Following a request to NMAS headquarters, the National Ocean Survey made charts available which TAMU reproduced in black and white, with the obstructions plotted. The university also published an accompanying book with the Loran A and fathometer readings for each obstruction. About 1600 copies of the draft edition of book and charts, covering most of the Texas and Louisiana coast from Brownsville to the Mississippi river, have been distributed to fishermen.

NOS has subsequently provided to TAMU reproduction material on which a new, color edition will be based.

Good cooperation in marine advisory services is being received from the Extension Service of the Department of Agriculture. For example, in several Sea Grant advisory programs Cooperative Extension has organized a marine component and the long experience of these organizations in extension work is being concentrated on marine problems.

Bill Wick at Oregon State University, previously an outstanding leader in wildlife extension, has now become interested in the management and conservation of estuarine environments. He is the first advisory service "graduate" to become Sea Grant Program Leader, which he did after several years as head of Oregon State University Marine Advisory Program.

Bruce Wilkins of Cornell, also a member of Cooperative Extension, is leading New York State's marine advisory program. Bruce is building a program of extension education for children in New York City, as well as assisting fishermen of Long Island.

Assistance is offered willingly by other federal agencies when called upon by the marine advisory service, and such cooperation is expected to increase in the future. One type of interagency assistance was shown in June 1973 when advisory staffs in Michigan, New York and Wisconsin needed information on problems being caused by high water levels in the Great Lakes. On relatively short notice a workshop type meeting was arranged by the NOAA Marine Advisory Service so that the advisory staff could receive a briefing and make the contacts needed to carry on their future work. The Corps of Engineers, Office of Emergency Preparedness, the National Weather Service and Lake Survey Center of NOAA, and the State of Michigan responded almost immediately, furnishing speakers and published background information. Here again, the personal contacts made, which led to further cooperation, were among the best results of this advisory service activity.

What about the future of marine advisory services? NOAA's goal is to see established a strong well-balanced advisory program in each marine and Great Lakes state. This growth will take place slowly, as local needs are defined. To assist in this effort, local Sea Grant programs are giving advisory services high priority, while at the NOAA level emphasis is upon increased service to the local needs and improved communication and cooperation among the affected components. □

NOAA AT HOME

If kids love anything more than a parade, it's radiosonde ascending the wild blue yonder. Once an hour, at the Sterling, Va., Research and Development Center, this occurred during NOAA's Washington-area 1973 Open House—usually, to the sound of cheers.

From coast to coast, NOAA observed its third anniversary in October by welcoming the public into its laboratories, offices, ships and other facilities.

Thousands, of all ages, attended. They trod the decks of oceangoing vessels, saw weather balloons launched—and, indeed, launched them; learned a little about what NOAA is and what it does.

The Washington open house was held at the NWS' Sterling Research and Development Center; attendance over the two-day period approached 10,000. Some of the youngsters who came on School Day wrote their impressions: "I liked the wind tunnel best . . . I liked the movies but you should get an air conditioner . . . the things I liked best were the freeze place and the wind place . . . the balloon launch was neato . . . inside the tent there were many things to see but it was crowded . . . I liked the big tent which had the flood warning bell . . . you do not know me but I would come again if you asked me . . ."

At Boulder, ERL held a mini-science fair; at Miami, the AOML and the NMFS' Southeast Fisheries Center welcomed visitors. At Woods Hole, hundreds visited their first Russian ship; at Auke Bay, Alaska, and Norfolk, Virginia, they toured NOAA vessels.

And so it went, in scores of large cities and small, in what has become one of NOAA's most pleasant young traditions. On these pages, memories of Open House.

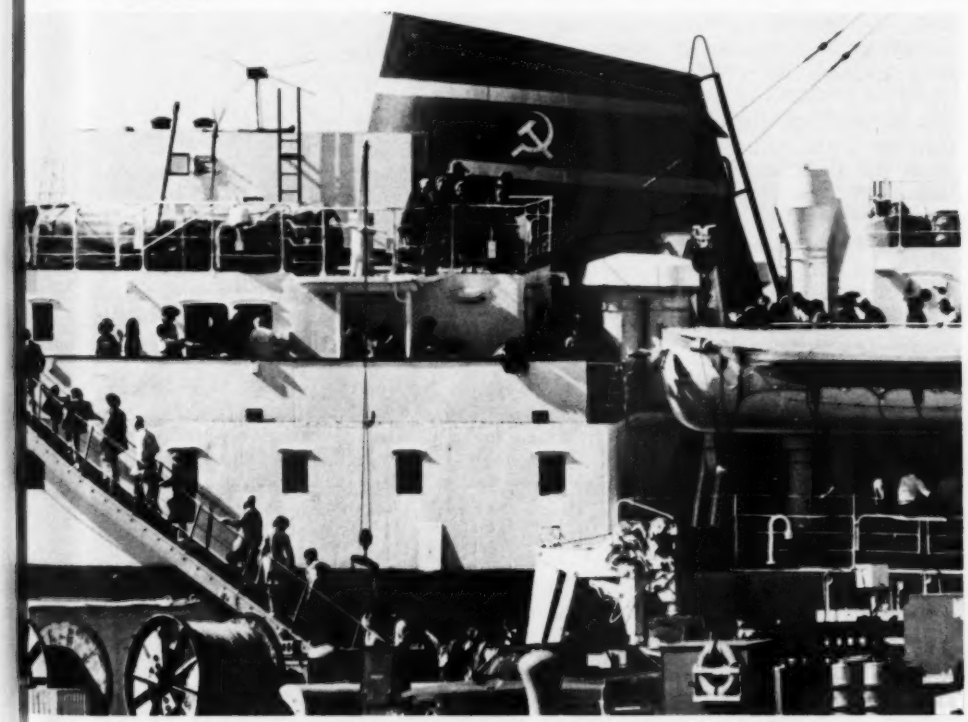
Deputy Administrator and Mrs. Howard W. Pollock, Associate Administrator and Mrs. David H. Wallace, at Sterling.

Ask Asheville: and hundreds did, as National Climatic Center welcomed all, from babes (above) to elderly.

Officers and crew of the NOAA Ship Fairweather and members of the Auke Bay Laboratory of the National Marine Fisheries Service disembark after a busy Open House day aboard the Fairweather.

That interested spectator (left) in blacked-out radar tent at Sterling was Dr. George P. Cressman, NWS Director.

NMFS scientist demonstrates to interested youngster at Sterling laboratory apparatus used in Red Tide studies.



Thousands of southeastern Massachusetts residents thronged the U.S.S.R. vessel Bela Gorsk at Woods Hole, Massachusetts, as the Soviets opened the research ship to public during NOAA's Open House there.

NMFS' home economist Arleen Joyce and Dr. Edward Epstein, Associate Administrator, discuss underused species.

National Ocean Survey expertise will help two states in

RECONSTRUCTING THE MASON-DIXON LINE

BY RAYMOND WILCOVE

Crown stone at Mile 105 West, Maryland side, as set by Mason and Dixon in 1767.

Part of the Mason-Dixon Line, the line that divides the North and South since 1768, has come unraveled. This year NOAA will help put it together again.

This is the famed line that divides Maryland and Deleware, and stretches south for some 87 miles from the Pennsylvania border about 30 miles below Philadelphia.

When Carles Mason and Jeremiah Dixon of England surveyed the line more than 200 years ago, it became the boundary between the British provinces of Pennsylvania and Maryland. A few years after their historic survey, the State of Delaware was formed from the lower three counties of Pennsylvania and the north-south portion of the Mason-Dixon Line became the Maryland-Delaware boundary.

Mason and Dixon delineated this boundary by placing 81 stone markers at one-mile intervals. Time and man have worked their will over the intervening 222 years. Some of the valuable limestone markers which bore the armorial shields of Lord Baltimore's family and that of the Penns have disappeared. Some were apparently carted away for other usage, one became a doorstep and others were simply displaced from their original locations. Some that are still in place are in a sad state of disrepair. Nothing much was done about it over the years, because the land wasn't too valuable, but this is no longer true.

In 1954, officials of Maryland and Delaware agreed on a plan for the restoration and maintenance of their boundary. Under this plan, the position of each boundary marker was to be located as accurately as possible and each marker was to be tied to the national horizontal network, maintained by the then Coast and Geodetic Survey, now NOAA's National Ocean Survey.

In accordance with the plan, the Coast and Geodetic Survey determined the geographic positions of all existing boundary monuments in 1961 and 1962. Of the 81 monuments established by Mason and Dixon 15 could not be found and have apparently disappeared and five were out of line.

Further operations were suspened after the 1961–62 survey until the states decided what to do about the stones that were missing or out of line. A decision has now been reached to replace the 15 missing monuments on the boundary.

The technical aspects of this task will not pose any insurmountable problems for the National Geodetic Survey, a unit of the National Ocean Survey which will assist the States of Maryland and Delaware in the adjustment of the border. But the human aspects of the job may prove more difficult.

During the 1961–62 survey, one boundary monument was located at the northwest corner of a house. Ray Tomlinson, Chief of the survey party, approached the house and began some measurements at the stone. Suddenly, the door opened and the lady of the house appeared, a shotgun cradled in her arm.

The following conversation ensued:

Lady—"Who are you?"
Answer—"I'm with the U.S. Coast and Geodetic Survey."
Lady—"What are you doing on my land?"
Answer—"We're resurveying the Delaware-Maryland boundary."
Lady (agitated)—"Are you going to move that stone?"
Answer—"No, ma'am."

Tomlinson, a veteran field party surveyman who is now stationed at National Geodetic Survey's Rockville, Md., headquarters, had learned over the years that irate landowners are not to be trifled with and had become a diplomat at turning away anger with a soft word.

He soon discovered why the lady was agitated. She was a resident of Delaware and had no intention of having federal surveyors change her state allegiance or having to pay taxes in two states. She made it quite clear in a few pithy sentences.

"No one," she said, and emphasized the point with a slight tilt of the shotgun in Tomlinson's direction, "is going to move that stone, no matter what your measurements turn up. You're not moving me into Maryland." Moving the stone two or three feet would put her property in both states.

Upon receiving assurances that the stone would not be moved, she permitted the survey to continue.

"On another occasion," Tomlinson recalled, "one of the one-mile markers could not be found and we inquired of the farmer who owned the property if he had any knowledge of its whereabouts.

He did and he pointed with his pitchfork to the marker. It lay near his barn. He said it had been located in the middle of his field and he had moved it to prevent further damage to his farm machinery. "I've spend hundreds of dollars repairing my machinery after hitting this mark," he told the survey party. "You can restore the marker to the field if you'll pay for past damages and all future damages to my equipment."

This stone still lies near his barn and the other marker remains near the lady's house, both out of line and both guarded by determined American taxpayers. Tomlinson didn't know how this and similar problems would be solved when the time came to straighten out the boundary.

"I guess it's up to the states," he remarked.

The uncertain location of a boundary can cause considerable confusion and sometimes prove costly. Thirteen years ago, a motorist was killed in a collision near the boundary between Delaware and Pennsylvania. Uncertainty arose as to the exact position of the boundary because some old line markers and landmarkers had been moved.

Was the motorist killed in Delaware or Pennsylvania? The Coast and Geodetic Survey delineated the correct boundary, but it took four months and $50,000 to do it. The authorities then decided that the fatal accident occurred in Delaware, one foot from the Pennsylvania state line.

Most of the Mason-Dixon Line represents the border dividing Pennsylvania from Maryland and West Virginia and extending from the Atlantic coast almost to the Ohio border. The epic task was performed by the two British astronomers and mathematicians for Thomas and Richard Penn, sons of the founder of Pennsylvania, and for Frederick Lord Baltimore of Maryland.

The offer by Mason and Dixon to fix the boundary between the two states came at a propitious time. For some 80 years, disputes over the boundary had led to lawsuits and even bloodshed. The 1763–68 survey established an enduring peace on the borders between the states and a symbolical dividing line between the North and the South which has lasted to this day.

It figuratively became an imaginary line which extended across the entire continent, although in its actual extent it never exceeded 233 miles, 13 chains and 68 links. (According to Webster's New Collegiate Dictionary, a chain is 66 feet and it takes 100 links to make one chain. A link is equivalent to 7.92 inches. Eighty chains make up a mile.)

In his bicentenary account of the work performed by the two Britishers, "The Mason and Dixon Line," Hubertis M. Cummings, a research associate of the Pennsylvania Department of Internal Affairs' Bureau of Land Records, points out that the two men were well equipped for their arduous task. Both were trainees of the famed Royal Society in England and of the Astronomers Royal of Greenwich Observatory. With the aid of the stars and a quintet of astronomical and other instruments, they persevered until they completed their survey. The instruments they used were the best available at that time, although they could not compare for accuracy with some employed today. They had no laser instruments such as those used by the National Geodetic Survey, instruments of such accuracy that federal surveyors are able to hold errors down to less than an inch in 10 miles. Nor did they have 20th century steel Bilby towers which tower up to 10 or more stories into the sky and enable the National Geodetic Survey to sight over trees, hills and other obstructions.

Despite this, Buford K. Meade, the National Geodetic Survey's Horizontal Network Division Chief, coud say after the 1961-62 survey of the Maryland-Delaware line that the results indicated that "the alignment of markers along the north-south boundary was determined by Mason and Dixon with an amazing degree of accuracy, considering the instruments available 200 years ago."

The markers themselves were impressive. Each was 34 inches long, 12 inches wide and 11 inches thick. They had been quarried, cut and carved on the Isle of Portland, Dorsetshire, England, and then transported to the colonies as ballast on the ship Betsy Lloyd.

The most exacting portion of the Mason-Dixon survey consisted of the east-west line between Pennsylvania, Maryland, and West Virginia. The route lay in virgin territory through which a path had to be hacked and about 40 axemen were hired for this purpose. Hills and mountains had to be climbed and rivers crossed.

When they reached the Allegheny Mountains, permission was sought from the Six Nations Indians. Agreement was negotiated by British colonial officials upon the payment of 500 British pounds and 16 Indians —three Onondagas and 13 Mohawks— joined the party to accompany them through their lands and protect them from marauding Indians.

(Mason and Dixon were admonished by the Colonial authorities to treat the Indians well because "the public Peace and your own Security may greatly depend on the good Usage and kind Treatment" of the Indians. The agreement also apparently provided that the Indians be given daily rations of liquor, but the two surveyors were urged to dilute the "firewater." The authorities recommended that "the Spirituous Liquors to be given to the Indians . . . be in small quantities mixed with water and delivered to them not more than three times every day.")

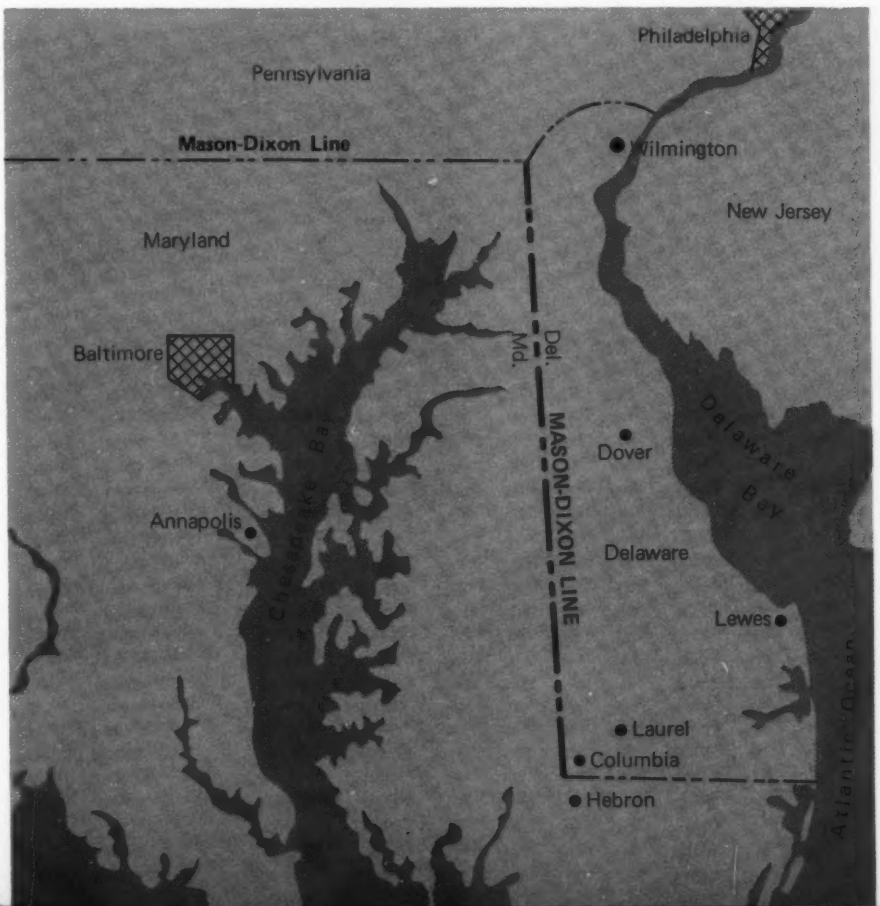
When they reached the Monongahela River, 26 white men in their party, largely axemen, refused to cross the river, afraid of the Shawnees and Delaware Indians on the other side. Mason and Dixon prevailed upon 15 axemen to continue with them and they pressed further westward.

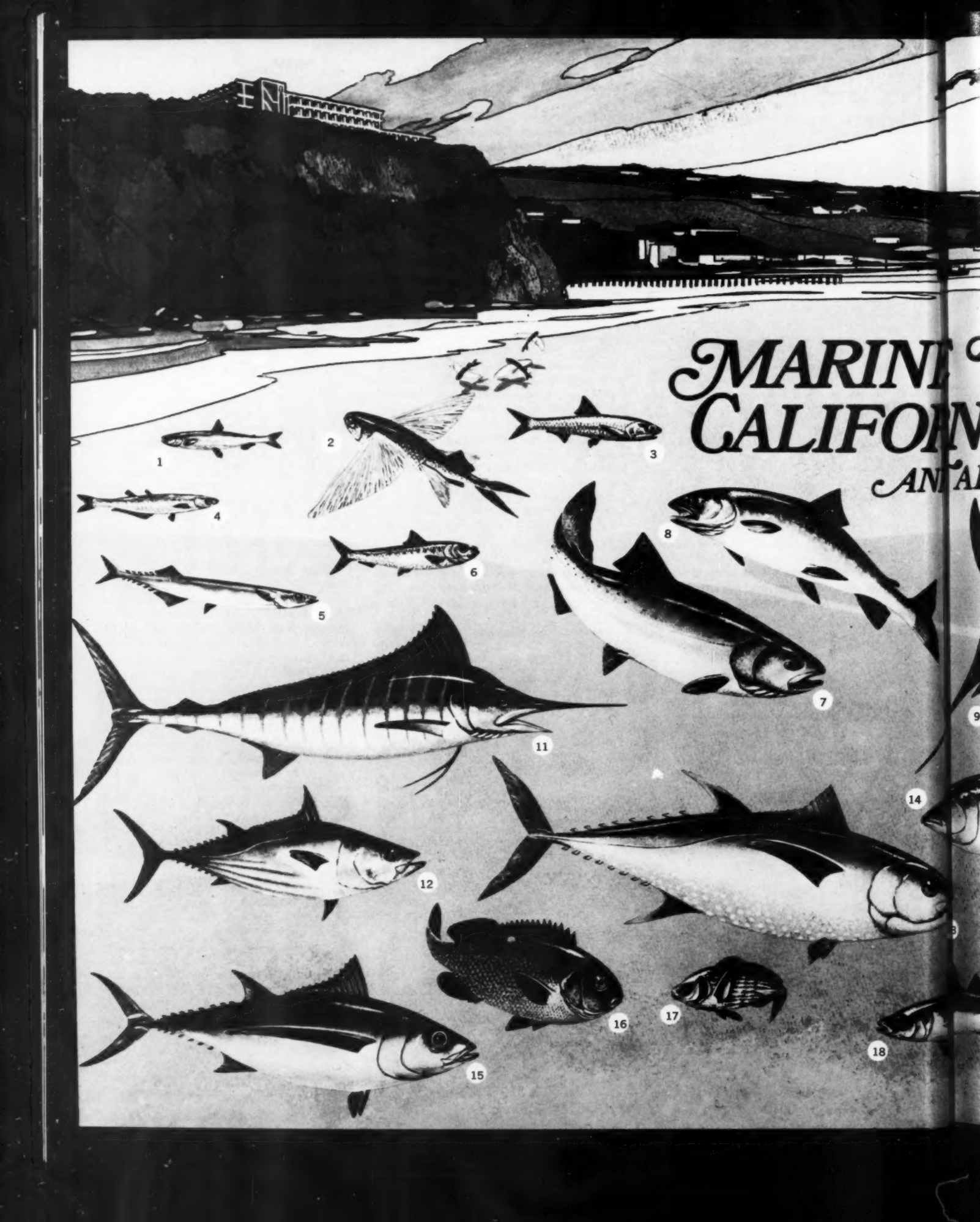
But their westward progress ended completely on October 10, 1767 when they reached Dunkard Creek and the chief of the Indians told them, "You go no further." Mason and Dixon were not inclined to argue the point. They were not unaware of the fact that the creek was named after a small town settled by Dunchards near the mouth of the Monongahela River which was burned and most of its inhabitants killed by Indians 12 years earlier. They had reached a point 230 miles, 18 chains and 21 links from the beginning of the line at the northeast corner of the Province of Maryland. That point was located on what is now the Pennsylvania-West Virginia border, about 16 miles southeast of Uniontown, Pa., and 45 miles due south of Pittsburgh.

Their survey completed, Mason and Dixon spent a month drafting the map of the routes they had laid out and returned to England. Dixon died January 22, 1779 and was buried in County Durham. Mason returned to Philadelphia and died there October 25, 1786. He was buried in Christ Church Burying Ground, where Benjamin Franklin also lies, but the location of his grave has been lost.

The man whose name is a household word in America lies in an unmarked grave. □

Solid line denotes part of Mason-Dixon line being repaired after generations of neglect. Rest, at top, goes west almost to Ohio line, dividing Pennsylvania from Maryland and West Virginia.

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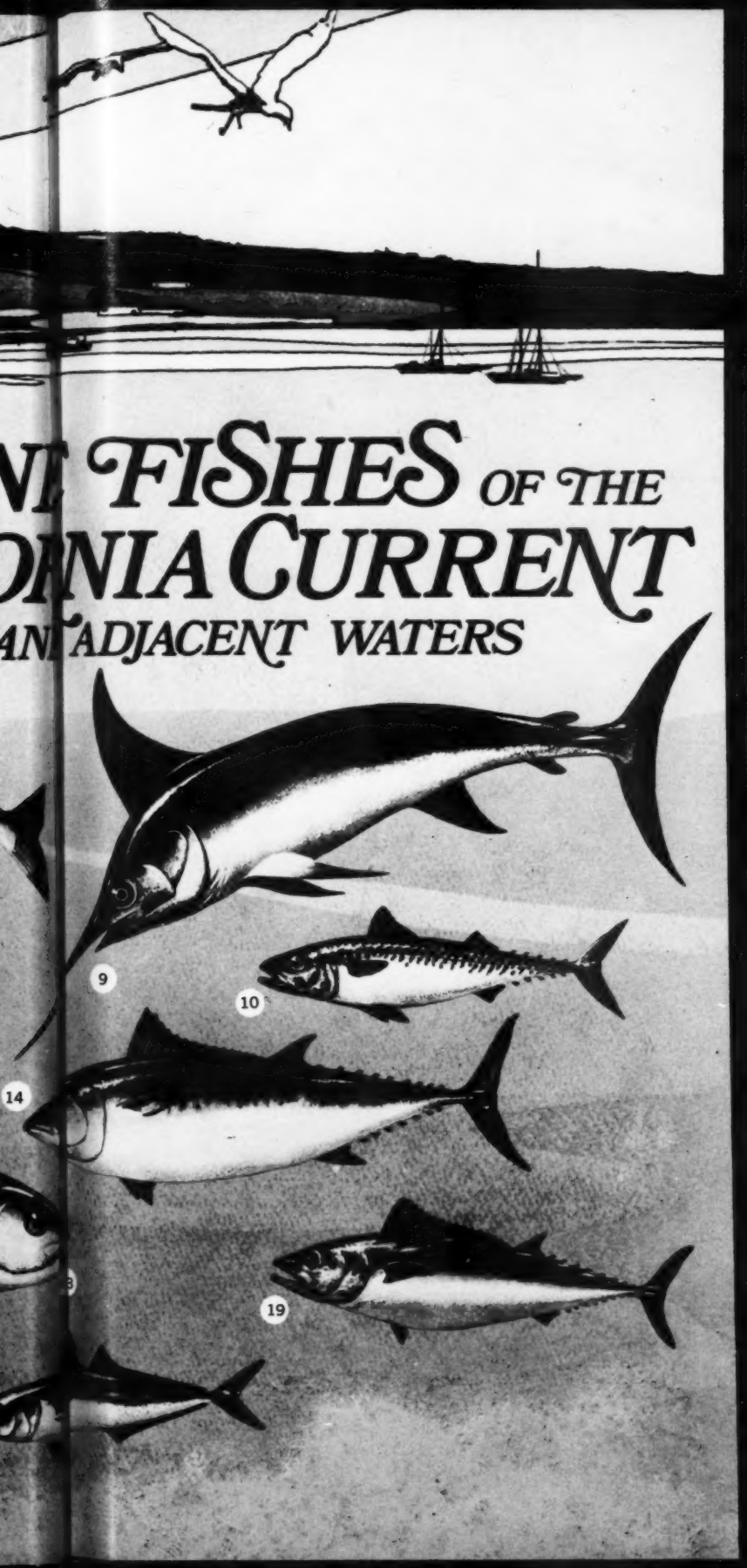

1. Surf smelt *Hypomesus pretiosus*
2. California flyingfish *Cypselurus californicus*
3. Northern anchovy *Engraulis mordax*
4. California grunion *Leuresthes tenuis*
5. Pacific saury *Cololabis saira*
6. Pacific sardine *Sardinops caerulea*
7. King (chinook) salmon *Oncorhynchus tshawytscha*
8. Silver (coho) salmon *Oncorhynchus kisutch*
9. Swordfish *Xiphias gladius*
10. Pacific (chub) mackerel *Scomber japonicus*
11. Striped marlin *Tetrapturus audax*
12. Skipjack tuna *Katsuwonus pelamis*
13. Yellowfin tuna *Thunnus albacares*
14. Bluefin tuna *Thunnus thynnus*
15. Albacore *Thunnus alalunga*
16. Opaleye *Girella nigricans*
17. Shiner perch *Cymatogaster aggregata*
18. Jack mackerel *Trachurus symmetricus*
19. Pacific bonito *Sarda chiliensis*

The scene at the top depicts two of the world's outstanding fisheries research centers. The prominent structure on the left represents the Southwest Fisheries Center of the National Marine Fisheries Service. Group of buildings to the right is the Scripps Institution of Oceanography, University of California at San Diego. Both facilities are located at La Jolla, California.

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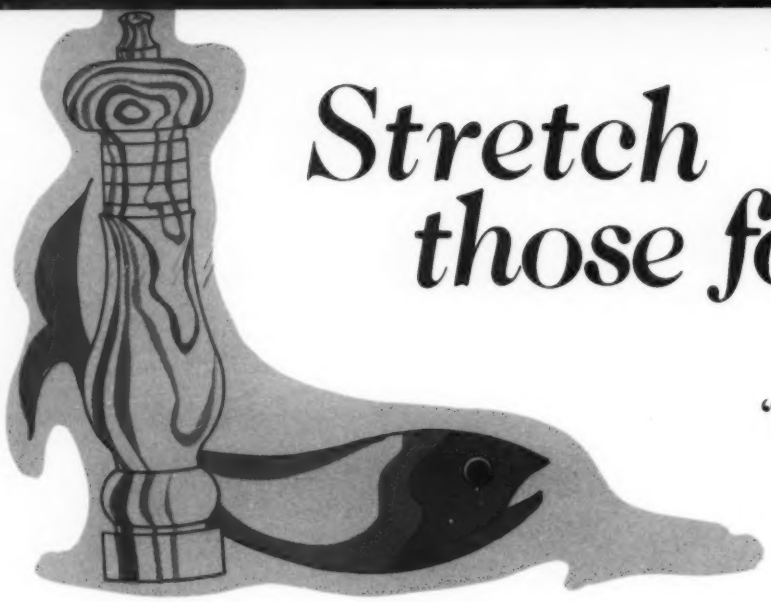
20. Striped bass *Morone saxatilis*
21. Leopard shark *Triakis semifasciata*
22. Blue shark *Prionace glauca*
23. Halfmoon *Medialuna californiensis*
24. California yellowtail *Seriola dorsalis*
25. California (Pacific) barracuda *Sphyraena argentea*
26. Pacific hake *Merluccius productus*
27. American shad *Alosa sapidissima*
28. California corbina *Menticirrhus undulatus*
29. Ocean sunfish *Mola mola*
30. Giant sea bass *Stereolepis gigas*
31. Blue rockfish *Sebastes mystinus*
32. White seabass *Cynoscion nobilis*
33. Sablefish *Anoplopoma fimbria*
34. California sculpin (scorpionfish) *Scorpaena guttata*
35. Kelp bass *Paralabrax clathratus*
36. Vermilion rockfish *Sebastes miniatus*
37. Barred surfperch *Amphistichus argenteus*
38. Garibaldi *Hypsypops rubicunda*
39. California sheephead (male) *Pimelometopon pulchrum*
40. Petrale sole *Eopsetta jordani*
41. Pacific sanddab *Citharichthys sordidus*
42. Bocaccio *Sebastes paucispinis*
43. English sole *Parophrys vetulus*
44. Round stingray *Urolophus halleri*
45. California skate *Raja inornata*
46. Cabezon *Scorpaenichthys marmoratus*
47. Lingcod *Ophiodon elongatus*
48. California moray *Gymnothorax mordax*
49. Rex sole *Glyptocephalus zachirus*
50. California halibut *Paralichthys californicus*
51. Dover sole *Microstomus pacificus*

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE

This chart was developed under the direction of Bob E. Finley, Chief, National Consumer Educational Services Office, National Marine Fisheries Service, 100 East Ohio Street, Chicago, Illinois 60611. Designer/Robert Meyer, Species Artist/Rod Ruth, Background Artist/Parker Heath.

Stretch those food dollars



"A little fish goes a long way"

"A little fish goes a long way."

That's the title of the latest collection of recipes published by the National Marine Fisheries Service's National Consumer Educational Services Office.

Each of the 25 recipes contained in the handy, pocket- or purse-sized booklet uses a pound or less of fish and serves at least four persons.

And that, indeed, goes a long way toward helping homemakers stay within their food budgets.

In the recipes, fish fillets, sticks, or portions, canned fish, and shellfish are combined with noodles, rice, spaghetti, beans, and other popular extenders, to create tasty, nutritious, and economical dishes.

Any kind of fish can be used in the entrees based on fillets, sticks, and portions, allowing shoppers to buy the most economical, seasonally available variety. The filleted, breaded, and canned fish ingredients are one hundred percent food, with no bones or fat to trim or throw away.

As an added aid in cooking and marketing the booklet suggests a complete menu to complement the flavor of each fish dish.

"A little fish goes a long way"—which includes the recipes presented here—is available for 50 cents a copy from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

SUGGESTED MENUS

fish entree	vegetable	salad	bread	dessert
Biscuit Topped Fish Stew		Crisp Lettuce Favorite Salad Dressing Carrot Sticks and Radishes		Cake Squares with Cherry Pie Filling Sauce
Crunchy Fish Noodle Bake	Buttered Broccoli Pieces	Chef's Salad Oil-Vinegar Dressing	Brown-and-Serve Rolls	Chilled Canned Apricot Halves Wafers
Dinner Bell Fish Soup-Stew		Tomato Slices on Lettuce Favorite Salad Dressing	Sea Toast or Hot Buttered Crusty Bread	Chilled Tapioca Pudding
Fish Sticks with Jalapeno Cornbread	Baked Beans	Tomato and Onion Slices Marinated in Oil Vinegar Dressing		Pineapple Rice Pudding Cinnamon Sugar Cookies
Fish Portion Stroganoff Casserole	Green Beans with Mushroom Stems and Pieces	Marinated Cucumber Slices and Pickled Beets	Rye Bread or Pumpernickle Bread	Chilled Cinnamon-Applesauce Cookies
Fish Portions Oriental	Buttered Peas with Sliced Water Chestnuts	Tossed Salad Greens Favorite Dressing	Bran Muffins or Pan Rolls	Molded Orange Gelatin with Banana Slices
Tuna and Noodles Italian Style	Pea with Mushroom Stems and Pieces	Green Beans and Onion a la Vinaigrette	Bread or Bread Sticks	Vanilla Pudding with Sliced Banana
Tuna Dinner Pie with Cheese Sauce	Tomato Slice Garnish	Tossed Salad Greens Russian Dressing		Lemon Pudding Sugar wafers
Salmon Casserole with Cornbread Topping	Creamed Peas	Tossed Salad Greens Russian Dressing	Corn Muffins	Fruit Cocktail in Strawberry Gelatin Cookies

FISH PORTIONS ORIENTAL

1 package (12 ounce) frozen breaded fish portions
1 can (13¼ ounce) pineapple chunks
2 tablespoons sugar
2 tablespoons vinegar
1 tablespoon soy sauce
1 tablespoon cornstarch
½ teaspoon garlic salt
½ medium green pepper, cut in strips
4 servings hot cooked seasoned rice

Heat fish portions as directed on package label. Drain pineapple chunks; save syrup. Add water as needed to pineapple syrup to make ¾ cup liquid. Combine liquid, sugar, vinegar, soy sauce, cornstarch and garlic salt in saucepan; mix well. Cook stirring constantly until sauce is thickened and clear. Add pineapple chunks and green pepper strips, heat. Serve fish portions on rice and spoon over fish. Makes 4 servings.

TUNA DINNER PIE WITH CHEESE SAUCE

2 cans (6½ or 7 ounces each) tuna
½ cup chopped onion
2 tablespoons margarine or cooking oil
2 tablespoons flour
½ teaspoon salt
Dash of pepper
1½ cups undiluted evaporated milk
2 eggs, beaten
9-inch unbaked pastry shell
Cheese Sauce (recipe follows)
Tomato slices, optional

Drain and flake tuna. Cook onion in saucepan in margarine or oil until tender, but not brown. Stir in flour, salt and pepper. Add milk; cook, stirring constantly, until thickened. Pour mixture over eggs very slowly, beating constantly. Bake in crust in moderate oven, 375°F., about 5 minutes. Remove crust from oven and spread tuna over crust; pour egg mixture over tuna. Return pie to oven; bake about 25 to 30 minutes or until filling is set. Let stand about 10 minutes before cutting into wedges. Serve with Cheese Sauce. Garnish with thin tomato slices, if desired. Makes one 9-inch pie, 4 to 6 servings.

CHEESE SAUCE

1 can (10¾ ounce) condensed cheddar cheese soup
½ cup undiluted evaporated milk

Combine soup and milk in saucepan; heat, stirring until hot and smooth. Makes 1¾ cups sauce.

FISH PORTION STROGANOFF CASSEROLE

1 package (12 ounce) frozen breaded fish portions
2 tablespoons melted margarine or cooking oil
1 tablespoon lemon juice
3 cups medium noodles (6 ounces), cooked and drained
1 can (8½ ounces) peas and carrots, drained*
1 can (10¾ ounce) condensed cream of chicken soup
½ cup dairy sour cream
½ cup milk
1 teaspoon Worcestershire sauce
½ teaspoon onion or garlic salt
Dash of pepper

Broil fish portions as directed on package label drizzling margarine or oil and lemon juice over portions before broiling. Combine noodles, peas and carrots, soup, sour cream, milk, Worcestershire sauce, onion or garlic salt and pepper; mix well. Pour into shallow 1½-quart casserole. Top with fish portions. Bake in moderate oven, 350°F., about 25 to 30 minutes or until noodle mixture is hot and bubbly. Makes 4 servings.

* 1 package (9 ounce) frozen peas and carrots, cooked and drained, may be substituted for canned ones, if desired.

BISCUIT TOPPED FISH STEW

1 pound fish fillets, fresh or frozen
2 cups cubed (½-inch) potatoes, fresh or canned
1 cup sliced carrots
1 cup sliced onion
2 cups water
2 tablespoons margarine or cooking oil
1½ teaspoons salt
Dash of pepper
2 tablespoons flour
¼ teaspoon poultry seasoning
1 can (8½ ounce) peas, drained
1 can (9½ ounce) refrigerated biscuits

Thaw frozen fish; cut into 1-inch pieces. Combine potatoes, carrots, onion, 1 cup water, margarine or cooking oil, salt and pepper in large saucepan or Dutch oven; bring to boil; cover and simmer on top of stove about 15 minutes or until vegeables are almost tender. Blend flour, poultry seasoning and remaining 1 cup water. Add to vegetables; heat until mixture thickens slightly. Add peas and fish; heat thoroughly. Edge pan with whole biscuits overlapping them slightly or cut biscuits into quarters and stand quarters upright around edge. Bake* uncovered in hot oven, 425°F., for 15 to 18 minutes or until fish flakes easily when tested with a fork and biscuits are done and browned. Makes 4 servings.

* If desired, biscuits may be cooked in stew in covered pan on top of stove about 15 minutes until fish flakes easily when tested wih a fork and biscuits are done. Sprinkle biscuits with paprika before serving.

CRUNCHY FISH NOODLE BAKE

1 pound fish fillets, fresh or frozen
1 can (11 ounce) mandarin orange segments
1 can (10½ ounce) condensed cream of mushroom soup
1 cup sliced celery
½ cup chopped onion
½ cup chopped salted peanuts
½ teaspoon salt
1 can (3 ounce) chow mein noodles

Thaw frozen fish. Cut into 1-inch pieces. Drain orange segments; save ¼ cup syrup. Save about ¼ of the orange segments for garnishing top. Combine soup, reserved orange syrup, remaining orange segments, fish, celery, onion, peanuts, salt and ½ of the noodles; mix. Spread mixture into a shallow 1½-quart casserole. Cover wih aluminum foil, crimping it to edges of casserole. Bake in moderate oven, 350°F., about 30 minutes. Uncover. Sprinkle with remaining noodles. Continue cooking about 10 minutes or until hot and bubbly and fish flakes easily when tested with a fork. Garnish with orange segments. Makes 4 servings.

SALMON CASSEROLE WITH CORNBREAD TOPPING

1 can (1 pound) pink salmon
1 can (10¾ ounce) condensed cream of mushroom soup
1 package (9 ounce) frozen cut green beans, thawed
½ package (1 pound 2 ounce) corn muffin mix (or 1¾ cups of dry mix)
¼ cup finely chopped green pepper, optional
¼ teaspoon dry mustard

Drain salmon; save liquid. Flake salmon; distribute evenly over bottom of shallow 1½-quart casserole. Combine soup, salmon liquid and green beans in saucepan; heat. Pour soup mixture over salmon. Combine corn muffin mix, green pepper and dry mustard in bowl. Add egg and ½ of the milk called for on package label and mix as directed in package directions. Spoon into 8 even mounds onto hot soup mixture. Bake in hot oven, 400°F., about 22 to 25 minutes or until topping is done and browned. Makes 4 servings.

Note: If desired the remaining ½ package of corn muffin mix may be prepared as directed on the package label. Bake in muffin pans and serve with casserole.

DINNER BELL FISH SOUP-STEW

- 1 pound fish fillets, fresh or frozen
- 2 cups water
- 1 cup elbow macaroni
- 1 cup sliced carrots
- 1½ cups chopped onion
- 1 teaspoon salt
- Dash of cloves
- Dash of pepper
- 1 can (11½ ounce) condensed split pea with ham soup
- 2 cups milk

Thaw frozen fish; cut into 1-inch pieces. Combine water, macaroni, carrots, onion, salt, cloves and pepper in large saucepan or Dutch oven; bring to a boil. Cover and cook slowly about 15 minutes or until carrots and macaroni are both tender. Stir in soup and milk; heat and stir until well mixed. Add fish pieces. Cover and cook about 10 minutes or until fish flakes easily when tested with a fork. Makes about 8 cups, 4 to 6 servings.

FISH STICKS WITH JALAPENO CORNBREAD

- ¾ cup flour
- ½ cup yellow corn meal
- 2 teaspoons baking powder
- 2 teaspoons sugar
- 1 teaspoon salt
- ⅓ cup milk
- 2 eggs, beaten
- 3 tablespoons melted margarine, bacon drippings or cooking oil
- 1 can (8¾ ounce) cream style corn
- 2 tablespoons finely chopped canned jalapeno pepper
- 1 cup shredded process American cheese
- 1 package (9 ounce) frozen fish sticks

Combine and mix first 5 ingredients in bowl. Add milk, eggs, margarine, drippings or oil, corn and pepper; mix until dry ingredients are moistened. Fold in ½ of the cheese. Turn into a greased shallow 1½-quart casserole. Push fish sticks into batter in rows along either side of casserole. Sprinkle remaining ½ cup cheese evenly over top. Bake in hot oven, 425°F., about 25 minutes or until cornbread is done. Cut in serving portions. Makes 4 servings.

TUNA AND NOODLES, ITALIAN STYLE

- 1 cup (9¼ ounce) tuna
- 1 cup sliced celery
- ½ cup chopped onion
- 1 can (1 pound) tomatoes
- 1 can (6 ounce) tomato paste
- ½ cup water
- 1 teaspoon sugar
- 1 teaspoon garlic salt
- 1 teaspoon oregano
- ½ teaspoon crushed sweet basil
- 4 ounces medium noodles, cooked and drained (about 3 cups uncooked)
- ¼ cup grated Parmesan cheese

Drain tuna; pour oil into saucepan. Flake tuna. Cook celery and onion in tuna oil until tender, but not brown. Add tomatoes, tomato paste, water, sugar, garlic salt, oregano and basil. Cover and simmer about 30 minutes or until flavors are blended. Fold in tuna. Spread ½ of the noodles over bottom of shallow 1½-quart casserole; top with ½ of the tuna mixture and cheese. Repeat using remaining ingredients. Bake in moderate oven, 350°F., about 30 minutes or until hot and bubbly. Makes 4 servings.

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French, U.S. Submersible Probes Study Mid-Ocean Ridge, Herring

Project FAMOUS Begins Dives

Plunging into the black depths of the great rift valley that splits the bottom of the Atlantic, the French submersible *Archimede* has successfully completed seven dives to open the series of underwater probes that will mark FAMOUS (French-American Mid-Ocean Under Sea Study).

FAMOUS is one of several scientific programs emerging from a bilateral agreement between France and the United States that is being coordinated in the U.S. through NOAA.

Exploring an area of the seafloor some 200 miles south of the Azores, *Archimede* made dives of as long as 9 hrs. 45 minutes, with a maximum of 6 hours on the bottom and reaching depths of 2700 meters (almost 9000 feet). The French Navy operated both the submersible and the tender ship *Marcel Le Bihan*. One U.S. scientist, Robert D. Ballard of Woods Hole Oceanographic Institution —which is providing scientific coordination of the project— joined French colleagues from the National Center for Exploitation of the Oceans (CNEXO) and National Center for Scientific Research in making the dives.

During the year, the U.S. planted bottom buoys and markers in the area, using a towed undersea mapping device, and the French Navy ship *D'Entrecasteaux* made a narrow-beam survey in the vicinity of the dive site. U.S. ships also undertook geophysical research as part of the project, and two British ships deployed bottom seismographs.

In 1974, the U.S. submersible *Alvin* and the French *Archimede* and *SP–3000* will dive on the ridge with geologists aboard as observers.

FAMOUS is a three-year study of the Mid-Atlantic Ridge, a major feature of the earth's surface that has not yet been investigated at close range. Accelerated plans for U.S.-French cooperation in this and other areas were announced in May by NOAA Administrator Dr. Robert M. White and Yves LaPrairie, Director-General of CNEXO.

French submersible Archimede *recharges batteries, after diving to inner floor of the rift valley of the Mid-Atlantic Ridge in opening on-site operations of Project FAMOUS. In 1974 she will be joined by U.S. submersible* Alvin *in joint project supported in U.S. by NOAA, National Science Foundation, and Navy.* (CNEXO Photo)

Scientists Use Rockets, Gather Ionospheric Data

An international group of scientists produced manmade, multicolored clouds in the ionosphere over the Brazilian coast in a project to examine some of the interesting characteristics of the nighttime ionosphere.

Dr. Ben B. Balsley and D. A. Carter, ionospheric physicists with ERL's Aeronomy Laboratory cooperated in this effort with Dr. Gerhard Haerendel, of the Max Planck Institute near Munich, West Germany, the expedition leader, and scientists from the University of California at Berkeley, and the National Aeronautics and Space Administration.

The researchers launched two 7,228-pound, NASA-built Javelin rockets from Natal, Brazil, about one hour after ground sunset. Each rocket released a cloud of metallic barium atoms some 300 miles above the earth. The barium cloud separated into two parts, of which one was ionized by the sun's rays still present at that altitude. This ionized part, visible as a purplish cloud, drifted westward and upward under the influence of the ionospheric electric and magnetic fields. The non-ionized part was visible as a bluish cloud, and drifted in the direction of the neutral wind at these heights.

The scientists were primarily interested in determining the evolution of the ionized cloud, particularly in terms of the motions of small-scale structures within the cloud that appear only some minutes after release. They believe that the determination of these motions will aid in the understanding of equatorial Spread F—a similar but invisible phenomenon occurring in the equatorial ionosphere at these heights during the same twilight periods.

"The idea we are investigating," Balsley explains, "is that the ionosphere over the magnetic equator at night may behave something like syrup in an overturned glass. It has been raised to very high heights, primarily by ionospheric electric fields, and tends to fall back down under the influence of gravity. But instead of moving downward with the same velocity in all regions, there may be a strong tendency for the ionosphere in different regions to move with different velocities."

NMFS Conducts Spawning Study

A four-week-long man-in-the-sea program was conducted near Gloucester, Mass., in October, to investigate herring spawning habits.

Herring, a food fish in both Europe and the United States, has long been known to experience great variations in supply from year to year. Since the 13th century, the relative abundance of the fish has been the subject of intense interest, but the ecological conditions governing supply have never been fully understood.

NOAA's National Marine Fisheries Service and Manned Undersea Science and Technology Program have joined in a five-year study of northwest Atlantic herring, in an attempt to find out more about the natural causes of rise and decline in herring abundance. The recent operations marked the onset of the third year of this study. Dr. Richard Cooper of the Woods Hole (Mass.) Laboratory, NMFS, is principal investigator.

Using the two-man submersible *Nekton Gamma* and the surface support ship *R/V Paul Langevin II*, diver-scientists and support personnel carried out diver operations in the vicinity of Jeffreys Ledge approximately 35 miles northeast of Gloucester. Depths within the dive area varied from 130 to 250 feet, with the bottom consisting chiefly of sand, gravel, and small boulders. Photographic documentation of observed conditions was obtained. The surface vessel conducted plankton tows and obtained a profile of water temperatures from the surface to the bottom at the completion of each day's submarine operations and on days too rough for the submersible to be used.

Jeffreys Ledge is heavily fished by both U.S. and foreign fishing fleets. The project included monitoring of commercial landings of herring to determine when spawning is likely to occur, based on the rate of development of sperm and eggs in fish brought in by commercial fishermen.

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Gold, Silver Medals

COMMERCE HONORS NOAA EMPLOYEES

NOAA employees received ten Gold Medals and 16 Silver Medals from Secretary of Commerce Frederick B. Dent in an honors award program in the Commerce Department auditorium.

Recipients of the Gold Medal, the Department's highest honor, were:

Dr. Robert B. Abel, Director of the Office of Sea Grant, for his direction of the National Sea Grant Program.

Dr. Elbert H. Ahlstrom, Senior Scientist at the National Marine Fisheries Service Southwest Fisheries Center in La Jolla, Calif., for his leadership in developing oceanic fish stock assessment by means of systematic surveys of eggs and larvae.

Dr. Eugene J. Aubert, for his leadership in directing the United States effort in the International Field Year for the Great Lakes.

J. Virginia Lincoln, Chief of the Solar-Terrestrial Data Services Division in the Environmental Data Service's National Geophysical and Solar-Terrestrial Data Center, in Boulder, Colo., for her role as a leader in the development of NOAA's scientific data management programs.

Dr. James D. McQuigg, Research Meteorologist in EDS, located at the University of Missouri, Columbia, for his significant contributions in the use of computer simulation of the environment to translate climatic data into realistic useful parameters.

Dr. J. Murray Mitchell, Jr., Project Scientist for climatology, EDS, for his sustained, outstanding leadership and accomplishments in developing environmental programs of major benefit to the Nation and the international scientific community.

Kenneth M. Nagler, Chief of the National Weather Service Space Operations Support Division, for his leadership in weather support for U.S. manned spaceflights.

Dr. William L. Smith, Chief of the Radiation Branch in the National Environmental Satellite Service's Meteorological Satellite Laboratory, for his work in conceiving, developing, and demonstrating pioneering techniques for obtaining vertical soundings of the atmosphere from satellites.

William M. Terry, Director of NOAA's office of International Affairs until his death last May, was honored posthumously for his leadership, unique knowledge, and experience in international fisheries affairs.

The eight-man staff of the National Weather Service River Forecast Center at Harrisburg, Pa., for extraordinary performance in issuing flood forecasts and warnings during Tropical Storm Agnes in 1972. Credited with saving many lives and much property were: O. D. White, Hydrologist in Charge; Donald J. Close, Principal Assistant; Hydrologists Lars Olaf Feese, Myron W. Gwinner, Michael C. Mark, Nicholas R. Pavick and Bruce A. Whyte; and Paul A. Marin, Hydrologist (Intern).

Silver Medals, the Department's second highest honor, were presented to:

Dr. Felix Favorite, a Supervisory Oceanographer at the NMFS Northwest Fisheries Center in Seattle, Wash.

James G. Howcroft, a Research Meteorologist in the Development Division of the NWS National Meteorological Center in Suitland, Md.

James C. Hunter, Leading Forecaster at the NWS Forecast Office in Washington, D.C.

Robert S. Ingram, Meteorologist in Charge of the NWS Forecast Office at Phoenix, Ariz.

Jerry E. Randall, Chief Boatswain on the NOAA Ship *Surveyor.*

Dr. Eugene M. Rasmusson, a Physical Scientist in EDS.

Wanda E. Ross, Supervisory Analog-Digital Specialist in EDS's National Climatic Center in Asheville, N.C.

George H. Schielein, Lead Aviation Forecaster at the NWS Forecast Office at Albany, N.Y.

Walter A. Schulz, Jr., a Meteorological Technician and Radar Specialist at the NWS Forecast Office in Jackson, Miss.

Commander R. Lawrence Swanson, for his work while he was Chief of the NOS Oceanographic Division.

George Taft, an Attorney in NOAA's Office of the General Counsel.

Commander Charles K. Townsend, for his work while he was Chief, Mapping, Charting and Geodesy, in the Office of the Associate Administrator for Marine Resources.

Julius Badner, Chief, and William A. Rammer, former Deputy Chief, of the Aviation Weather Forecast Branch at the NWS National Meteorological Center in Suitland, Md.

Burton D. Goldenberg, former Chief, and LeRoy S. Nordahl, Staff Meteorologist, of the Rawinsonde Section of the NWS's Data Acquisition Division.

Robert H. Hanson, Research Photogrammetrist, and Chester C. Slama, Cartographer in Photogrammetry, in the NOS's Geodetic Research and Development Laboratory in Rockville, Md.

Dr. Isaac Van der Hoven, Chief, and Research Meteorologists Gilbert J. Ferber and Jerome L. Heffter, of ERL's Air Resources Environmental Laboratory in Silver Spring, Md.; George C. Holzworth and Paul A. Humphrey, Supervisory Research Meteorologists assigned to the Environmental Protection Agency's Meteorology Laboratory at the National Environmental Research Center, Triangle Park, N.C.; and Ralph F. Quiring, a Meteorologist at the Air Resources Laboratory in Las Vegas, Nev.

New Chart Sale Data Made Available

New information is available on how to use nautical charts as decorator items (published in the October issue of NOAA Magazine.)

National Ocean Survey nautical chart catalogs may be requested by mail from the Distribution Division (C44), National Ocean Survey, Riverdale, Md. 20840. The chart sales counter at 6501 Lafayette Avenue, Riverdale, is open from 8:30 a.m. to 4 p.m.; the telephone number is 301-344-2613.

The folio of reproductions of 20 Civil War maps mentioned in the article is out of stock and will not be reprinted.

NOAA-3 SATELLITE AIDS GLOBAL WEATHER WATCH

The day-and-night watch on the earth's atmosphere and oceans is continuing by a new National Oceanic and Atmospheric Administration satellite, launched November 6.

Designed and developed for NOAA by the National Aeronautics and Space Administration, the spacecraft—designated NOAA–3—is in a 942-mile-high orbit.

Radiometers on board the spacecraft provide visible and infrared images of cloud cover, snow and ice, and the sea surface, and gather information on temperatures and moisture in the atmosphere. Another sensor provides data on the solar proton count and distribution in polar regions.

The new spacecraft is the first to transmit local-area atmospheric radiance data—from which temperature soundings can be calculated—directly to properly equipped ground stations. Several foreign countries, including Norway and France, receive and process these atmosperic soundings for operational use in weather forecasting.

NOAA–3 maintains the operational satellite system that for more than 7½ years has provided regular global observations of cloud systems and other environmental features for the forecast and warning services of the United States and other nations.

Images of global weather and soundings of atmospheric temperature and moisture are used to improve the accuracy of large-scale weather forecasts prepared by the National Weather Service's National Meteorological Center at Suitland, Maryland. Data transmitted directly from the spacecraft to weather stations throughout the world has provided unprecedented observational coverage to other nations.

Since the beginning of the operational satellite system, probably no tropical storm at sea has gone undetected. Countless thousands of lives have been spared in the United States and abroad because of the satellites' early detection and continued tracking of hurricanes and tropical storms. A weather satellite was credited with saving the Mexican town of Gomez Palacios from devastation in November 1968; the pictures were used by Mexican authorities in managing a reservoir when storm rains threatened to break its dam and inundate the city.

Data from the operational system has led to improved severe local storm warnings, better predictions for the U.S. west coast where systems approach from the sea, and more accurate forecasts for aviation and for ocean shipping. The satellites' images also provide vital information on ice in the Great Lakes and in polar regions, seasurface temperatures, and snow cover.

Three Nations Join In Geodetic Net

The United States, Canada, and Mexico have undertaken a major program to modernize the geodetic network which provides the basis for all accurate horizontal surveying on the North American continent.

The United States portion of the program is being conducted by the National Geodetic Survey. Efforts of the three governments are coordinated by Cdr. John D. Bossler, Scientific Advisor to the Director of the National Geodetic Survey; L.A. Gale, Chief of the Geodetic Survey of Canada in Ottawa; and Eng. J. Alberto Villasana, Secretary of the Office of the President in Mexico City. Mexican participation in the program is being handled by the National Territory Studies Commission (CETENAL). The Mexican horizontal network comprises approximately 2000 geodetic survey points, the Canadian horizontal network about 8000 points, and the American network an estimated 120,000 points. The United States horizontal network, along with a similar national network of elevations, provides an accurate base for the production of topographic maps and navigational charts; the determination of national, state, and local boundaries and private property lines, the planning and construction of highway systems; geologic and hydrographic surveys; the planning of space flights; and irrigation, flood control, and hydroelectric projects, among others.

Soviets Study Marine Mammals

Two Soviet scientists spent six weeks in the United States studying marine mammals, as part of the 1972 Environmental Protection Agreement between the two countries.

The visit was the first implementation of the agreement under the Endangered Species and Wildlife Conservation Working Group, Marine Mammals Subgroup, administered for the United States by the National Marine Fisheries Service.

Weather Modification Reporting Changes Proposed by NOAA

NOAA has announced a proposed change in weather modification reporting rules, requiring operators to submit information on safety and environmental precautions taken in their projects. In addition, Federal agencies began reporting their weather modification activities to NOAA on November 1, 1973.

Public Law 92–205, passed by Congress in 1971, required all non-Federal weather modification projects conducted within the United States and its territories to be reported to the Secretary of Commerce. The reporting requirement became effective November 1, 1972, with NOAA carrying out the program.

The reports required by the proposed rule changes would establish an archive of information on safety practices and environmental precautions employed in weather modification activities. If, after considering a weather modification activity report, NOAA finds that a proposed project does not include adequate measures to protect persons, property, or the environment—or that it might adversely affect Federal research programs—the agency will notify the operator and State officials, informing them of commonly used safety procedures or of the Federal research projects involved.

New School, TV Obtained By Aleuts

The 450 residents of a remote community in the Pribilof Islands now have a new school and, for the first time, a home television service.

The National Marine Fisheries Service has opened a new school on St. Paul Island, one of the two inhabited islands of the chain, about 900 miles southwest of Anchorage in the Bering Sea. The school provides education for about 140 Aleut students.

The residents also have a closed circuit television, under a special Federal low power license issued only in Alaska. Its limited range is suitable only for isolated areas; the new "mini-tv" does not even reach St. George, the other inhabited island, about 40 miles away.

William L. Peck, Director of the Pribilof Island Program, said the new school replaces a deteriorating three-story structure built in 1930 and enlarged in 1949. By special arrangement with the State of Alaska, funds were appropriated for construction and made available to the Federal Government subject to repayment on an amortization schedule.

Ward Honored For EEO Work

Maurice A. Ward, a radar specialist with the National Weather Service's Office in Palmdale, Calif., has won NOAA's 1973 Equal Employment Opportunity Award.

The award, in the form of a plaque, was presented to Mr. Ward by Dr. Robert M. White, NOAA Administrator, in a ceremony held October 12 in Silver Spring, Md.

Mr. Ward was honored for positive and significant contributions toward the development of equal employment opportunities for minorities. After being assigned to Palmdale in June 1971, he became aware that the area's black youth needed help in finding available job openings and in learning proper job application procedures. Mr. Ward organized a group of high school counselors, businessmen, and clergymen to meet with minority-group youth and provide instruction.

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Dent Names Advisors On Coastal Zone

Secretary of Commerce Frederick B. Dent has established a Coastal Zone Management Advisory Committee and appointed fifteen distinguished persons to serve as members. The Committee held its first meeting, Nov. 15.

Purpose of the committee, as provided by the Coastal Zone Management Act of 1972, is to advise, consult with, and make recommendations to the Secretary on matters of policy concerning the coastal zone. Coastal zone matters relative to the Act that the committee may deal with include implementation and administration of the Act; proposed legislation or revisions to the Act that appear to involve coastal zone policy; public awareness and concerns about specific management issues such as conservation, protection, and resource development; and Federal activities in the coastal zone related to administration of the Act.

The Committee reports to the Secretary through the Administrator of NOAA. Robert W. Knecht, Director of NOAA's Office of Coastal Environment, serves as Chairman of the Coastal Zone Management Advisory Committee.

Members of the Committee serve two-year terms, except that seven initial appointments are for one year terms.

Members appointed for terms expiring in September, 1974 are:

Edward Bertrand of St. Thomas, U.S. Virgin Islands, General Manager of the Lagoon Marina in St. Thomas.

Dr. William H. Fisher, Director, Bureau of Economic Geology, University of Texas.

Charles E. Fraser, President of the Sea Pines Company, a land development firm located on Hilton Head Island, South Carolina.

Dr. Charles E. Herdendorf III, Director of Ohio State University's Center for Lake Erie Area Research.

Dr. Y. R. Nayudu, a marine geologist, Director of the Division of Marine and Coastal Zone Management of Alaska's Department of Environmental Conservation.

John Spellman, County Executive of King County Washington, the county surrounding Seattle.

Scott C. Whitney, a Professor of Law and Director of the environmental law program at the College of William and Mary in Williamsburg, Virginia.

Members appointed for terms expiring in September, 1975, are:

Harry C. Brockel, retired Director of the Port of Milwaukee and currently a lecturer at the University of Wisconsin's Great Lakes Study Center.

Robert Bybee, Operations Manager of the Exxon Company's Exploration Department.

William B. Hannum, Jr., President of Sea Farms, Inc., of Key West, Florida.

Ellen Stern Harris, Vice Chairman of the California Coastal Conservation Commission.

Dr. Lee Koppelman, Executive Director of the Nassau-Suffolk (N.Y.) Regional Planning Board.

Dr. Lyle S. St. Amant, Assistant Director of the Louisiana Wildlife and Fisheries Commission.

W. Reid Thompson, President of the Potomac Electric Power Company.

Mayor Peter Wilson of San Diego, author of the first coastal protection legislation to be introduced in the California legislature.

Scientists Study Aviation Hazard

Recent research at the Environmental Research Laboratories indicates that an invisible aviation hazard—atmospheric turbulence—may be audible to very sensitive microphones.

Atmospheric turbulence affects aircraft even when they fly "above the weather," its consequences ranging in severity from a little roughness to control problems. Invisible in clear air, turbulence has been extremely difficult to detect and study.

Alfred J. Bedard, Jr., a physicist with ERL's Wave Propagation Laboratory has discovered a relationship between turbulence reported by airline pilots, mountainous sources of infrasound (sound waves pitched too low for human ears to hear), and subsonic pressure disturbances in the atmospheric, which move much more slowly than the speed of sound.

The NOAA scientist made a study of these phenomena between February 1972 and June 1973 as part of a cooperative program with Dr. Douglas K. Lilly of the National Center for Atmospheric Research. Data from arrays of microphones positioned in mountainous regions near the Continental Divide showed that commercial aircraft reports of turbulence occurred in the vicinity of sources of infrasound in 14 of 29 cases.

"The infrasound source activity seemed to peak during the winter months—a result which agrees with previous research," Bedard says. "And the low-frequency sounds usually lasted several hours.

Subsonic pressure disturbances also occurred during intervals of aircraft turbulence reported by airline pilots, and matched upper-level wind speed and direction at the 33,000-foot level. Moreover, the measurements agreed in source direction and propagation time between two microbarograph stations at Boulder and Fraser, Colorado.

"When microbarograph recordings of pressure fluctuations which passed over Fraser, the Continental Divide, and on to Boulder were superimposed on one another, they corresponded very closely," the Colorado scientist explains. "Features of the disturbances were still recognizable, thus supplying us with a method of tracing the movement of pressure fluctuations over long distances."

He has concluded that a preferred region for generation of infrasound is in the lee of the Continental Divide in the Rocky Mountains near Boulder.

NMFS Director Commends Whale Rescues

The Director of the National Marine Fisheries Service, Robert W. Schoning, commended the cooperative efforts of the North Carolina Fisheries Commission, students and faculty of the University of North Carolina, NMFS personnel, and other volunteers for their role in rescuing at least a dozen whales that had beached themselves near Beaufort, North Carolina, on October 10 and 11.

The volunteer efforts became necessary when about 35 or 40 pilot whales beached themselves in Barden's Inlet, near Cape Lookout Light, along several miles of marshland and sandy shore. Local whale watchers called the event the most extensive mass beaching in local memory. The stranded marine mammals (known also as "blackfish" and "pot heads") ranged in size from a four-foot new baby to specimens as long as 25 feet and weighing from 400 to 1,500 pounds.

North Carolina Fisheries Commissioner Ed McCoy called on NMFS for assistance, and the director of the Atlantic Estuarine Fisheries Center at Beaufort, Dr. Theodore R. Rice, assigned a dozen members of his staff and three research boats to join the salvage operations. The State Fisheries Commission and the University of North Carolina also assigned boats to the task.

Rescue procedures were catch-as-catch-can, as few of the people involved had any previous experience in similar situations. A spotter plane flown by a North Carolina enforcement officer directed the boats equipped with radios to the locations of beached whales while the other boats criss-crossed the inlet seeking the animals.

If the animals were still alive (many were already dead or in death throes when located), rescuers had to push, pull, hoist, or drag the heavy bodies to deeper water, then tie thick nylon rope at the base of the tail (called the flukes). Once secured, the live whales were towed out to sea, with the boats slowing to a near stop every few minutes to allow the animals to surface and breathe.

"The entire rescue operation was handled extremely well," Mr. Schoning said. "This is a striking example of how voluntary cooperation within the spirit of the Marine Mammal Protection Act of 1972 has benefited both the ocean environment and marine mammals."

noaa/people

Thomas Winterfeld, Director of the National Oceanographic Data Center's Development Division, has been appointed U.S. delegate to the Hydrography Committee of the International council for the Exploration of the Sea.

Edward E. Edstrom, of the Environmental Data Service's National Climatic Center, Asheville, N.C., has recently been appointed to the Operations Working Group of the Scientific Advisory Group on upper air observations.

Mary V. Boylen, formerly a records and research assistant with the Civil Aeronautics Board, is the new Administrative Officer of the Environmental Data Service's Environmental Science Information Center.

Mary E. Pratt, Library Technician at the Environmental Data Service's National Oceanographic Data Center Library in Washington, D.C., recently received a Certificate of Accomplishment for Library Technicians from the Graduate School, U.S. Department of Agriculture.

Lorry M. Nakatsu has been appointed U.S. Regional Fisheries Attache to Tokyo. Until recently, he headed the Foreign Fisheries Program in the International Activities Staff of the National Marine Fisheries Service.

Dr. Jay C. Quast of the National Marine Fisheries Service's Auke Bay Fisheries Laboratory in Auke Bay, Alaska, was awarded a plaque and a check in the amount of $150 at the 103rd Annual Meeting of the American Fisheries Society recently, for the best paper in Volume 101 of the Society's *Transactions*.

Dr. John Roberts, a physiologist and Professor of zoology at the University of Massachusetts, recently received a National Research Council Senior Research Associateship, awarded by NOAA and the National Marine Fisheries Service. He will devote the next 12 months to studies of the respiratory systems of scombroid fishes (tunas and tuna-like species), at the NMFS Southwest Fisheries Center, La Jolla, Calif.

Biologist Richard S. Shomura, until recently the Director of the National Marine Fisheries Service Tiburon (Calif.) laboratory, has assumed the directorship of the Honolulu laboratory, which is under the direction of the NMFS Southwest Fisheries Center at La Jolla, Calif.

Clyde L. MacKenzie, Jr., fishery biologist, has joined the NMFS's Middle Atlantic Coastal Fisheries Center, after completing a one year special duty assignment in Canada as Oyster Consultant to the Department of Fisheries, Province of Prince Edward Island. At MACFC, Mr. MacKenzie will play an important role in ongoing resource studies of the New York Bight.

Douglas L. Davis, Principal Assistant at the Richmond, Va., weather station, has been selected to head the National Weather Service Office at Huntsville, Ala.

Allen G. Kornmann has been selected for the position of Program Analyst in the National Weather Service's Manpower Utilization Staff. He will manage the NWS Field Office Manpower Management and Utilization Survey.

Paul W. Daily, Jr., is the new Meteorologist in Charge of the Cincinnati, Ohio, Weather Service Office. He has served as a lead forecaster in Des Moines, Iowa, for the past two years.

Milton I. Rudd, who has been a Weather Service specialist at the National Weather Service Office in Lake Charles, La., since 1969, is the new Official in Charge of the WSO in Winnemucca, Nev.

Joe G. Walker, Weather Service Evaluation Officer at the Weather Service Forecast Office in Memphis, Tenn., has been promoted to the rank of Colonel in the Tennessee Air National Guard, and is now assigned to Headquarters, Tennessee Air National Guard, Nashville, as Weather Staff Officer.

Thomas A. Rush, Aviation Services Quality Control Officer at the National Hurricane Center at Miami, has been selected to head the National Weather Service Office at Tallahassee, Fla.

Dr. Harry R. Glahn, Chief of the Objective Forecast Branch in the Systems Plans and Design Division's Techniques Development Lab of the National Weather Service's Systems Development Office, has been promoted to the rank of lieutenant colonel in the U.S. Air Force Reserve.

Fred A. Davis, Jr., has been appointed Meteorologist in Charge at the Baltimore, Md., Weather Service Office, where he was Principal Assistant.

Gemo Yakubovsky has been named program leader for Aviation services at the National Weather Service Western Region Headquarters in Salt Lake City, Utah. He had served as Quality Control Officer at the Los Angeles, Calif., Weather Service Forecast Office since 1962.

John Gruber has become Meteorologist in Charge at Houghton Lake, Mich. He was Chief of the Public Service Unit at the Weather Service Forecast Office in Chicago, Ill.

Herbert L. Moore has been named Official in Charge at the Weather Service Office in Colorado Springs, Colo. For the past two years he has been a Weather Service Specialist at the WSO in Aberdeen, S. Dak.

Evan L. McColly, who has been the Supervising Meteorological Technician at the Weather Service Forecast Office in Indianapolis, Ind., has been reassigned as Official in Charge at Fort Wayne,

Jack B. Hughes, Quality Control Officer at the National Weather Service Forecast Office in Great Falls, Mont., has been selected to be the Meteorologist in Charge at the Wichita, Kans., Weather Service Office.

Amos Perry is the new skipper of the Lake Survey Vessel *Laidly*. He holds a Coast Guard Operator's License for the Great Lakes and Florida's inland waters and is also an experienced commercial radio announcer.

William M. Nicholson, Associate Director, Office of Marine Technology, National Ocean Survey, is Co-Chairman of a U.S.-Japanese Panel on Marine Facilities. The panel functions for exchange of technical information or natural resources under a U.S.-Japanese agreement.

Dr. Robert Kay has been appointed Chief of Operations in the National Ocean Survey's Office of Marine Technology. The engineer-scientist was previously with the NOAA Office of Marine Resources.

Dr. James H. Saylor, Chief of Lake Survey Center's Water Motion Branch, has recently been appointed to the Federal Regional Council's Shore Land Damage Prevention Task Force. The goal of the Task Force is to help reduce damage to Great Lakes coastal lands in cooperation with other concerned organizations.

Margaret F. Kerr is the new Administrative Officer of the National Ocean Survey's Atlantic Marine Center.

Lieutenant Commander Fidel T. Smith has been named to command the National Ocean Survey's new Atlantic Hydrographic Field Party. The party, under the Atlantic Marine Center, comprises Hydrographic Field Parties 742, 745, and 746 (Launch 1257).

Lieutenant Commander John C. Veselenak, who has been Operations Officer of the *Whiting* for the past ten months, is her new Executive Officer.

Lieutenant Albert E. Theberge, Jr. is now the *Whiting's* Operations Officer.

Commander K. William Jeffers has been appointed Commanding Officer of the NOAA Ship *Rainier*. He was formerly Executive Officer of the *Oceanographer*.

Commander Charles K. Townsend is the new Executive Officer of the NOAA Ship *Oceanographer*. He was last assigned as Chief of the Office of Plans and Programs' Solid Earth Division at NOAA headquarters.

Dr. L. Bajorunas, Chief of the Lake Survey Center's Limnology Division, has recently won professional recognition for his work. One of his papers, "Shifting Offshore Bars and Harbor Shoaling," prepared jointly with Dr. D. B. Duane (at present with Coastal Engineering Research Center), was selected as a benchmark paper in geology.

Ensign Bryon K. Mezger, of Marble Falls, Tex., has been named the outstanding student of the 45th Officer Training Class of the NOAA Commissioned Corps. He is a graduate of Texas A&M University.

Lieutenant William R. Daniels is attending the U.S. Naval Oceanographic Office's International Allied Hydrographic/Oceanographic Training Program for Officers and Civilians, in Washington, D.C.

Dr. George Freeland, an oceanographer at the Marine Geology and Geophysics Laboratory (part of the Environmental Research Laboratories' Atlantic Oceanographic and Meteorological Laboratories), has been elected President of the Miami Geological Society at its annual meeting.

Ms. Eleanor Shannon has been designate as the NOAA Special Emphasis Programs Coordinator. She is responsible for administering the Federal Women's Program, the Spanish-Speaking Program, and the Handicapped Program.

Lightning Warning

NEW SPACE CENTER SYSTEM AIDS HAZARD DETECTION

For the Kennedy Space Center, lightning has been a persistent saboteur, striking swiftly, destroying crucial electronic circuits, unbalancing the delicate electronic memories of unlaunched satellites.

NOAA researchers, supported by the National Aeronautics and Space Administration, have now devised a system that greatly improves the ability of Space Center personnel to anticipate, and counter, the destructive intrusions of this electric enemy.

Because central Florida is the thunderstorm capital of the United States—thunderstorms are observed there on more than one hundred days in an average year—these massive electrical discharges have always been an enemy to people and equipment at the Space Center. The point was made most emphatically when lightning struck Apollo 12 during liftoff several years ago.

After the Apollo 12 incident, a project was begun by the Atmospheric Physics and Chemistry Laboratory to develop an improved ligthning warning system that would help NASA officials to anticipate potential lightning strikes in and around launch areas, and to take appropriate action. This system is now installed at the Kennedy Space Center.

According to Dr. Heinz W. Kasemir, who leads the project for NOAA, the work has emphasized the cause-and-effect relationships between rockets and lightning discharges, and the best methods of monitoring and displaying the local lightning.

"The present system consists of a network of instruments to measure the electric field in the Cape Kennedy area, and a weather radar to monitor precipitation in rain clouds. This information is fed into a computer, and displayed in the form of electric field contour maps of the launch area.

At present, 25 electric-field meters installed around the Space Center collect data once per minute for cable relay to a central recording and processing site.

In the NOAA-designed network, a triangular array of three cross-loop antennas measures which clouds have had lightning discharges within any prior ten-minute interval. A weather radar detects precipitation (another sign of possible electrical activity) over the area.

Eventually, the lightning hazard monitoring network will comprise 50 stations and will display data directly on a color television console showing a map of the area, electric-field contours, and lightning discharges at one-minute intervals. The computer-produced video display will show the total electrical activity of nearby storms in real time, with radar contours of precipitation in one color, electric field contours in another, and the positions of lightning strokes in a third.

It is also expected that, over a period of time—perhaps over the schedule of the Space Shuttle, expected in the late 1970's—new techniques of lightning suppression or mitigation now being explored by the Atmospheric Physics and Chemistry Laboratory may be applied at the Space Center. The object here would be to do something about the destructive intruder instead of scrubbing a launch on account of weather.

NOAA scientists believe the lightning tracking system has other applications as well. In its present form, it would be valuable near nuclear test sites, where elaborate electrical systems are susceptible to lightning damage.

NOS Solves Short Circuit Problem At Sea

The National Ocean Survey has found the solution to a problem that has hampered radio communications at sea during stormy weather since ships first began using wireless.

During heavy weather of long duration, salt spray and water often short-circuit the insulators of radio antennas.

The radio antennas used for transmitting and receiving messages by radio telephone and telegraph are isolated from the ship's steel structure by porcelain insulators located near the deck at the base of the antennas. As long as these insulators are clean and dry and have a high polish, they prevent the electrical current in the antennas from short-circuiting to the ship's steel hull. But when these insulators become covered with salt crystals from ocean spray and rain water from squalls, the electrical current is diverted to the steel hull.

This problem has now been solved by coating the porcelain insulators with a silicone grease to which water will not adhere.

The method was conceived and developed by William F. Seibold, Sr., a naval architect technician with NOS's Office of Fleet Operations, with an expenditure in hardware of only $2200.

Russell Train, right, Administrator of the Environmental Protection Agency, introduces President Nixon to two visiting Soviet environmentalists at the White House. Fron left, Academician E. K. Federov of the U.S.-U.S.S.R. Joint Committee on Cooperation in the Field of Environmental Protection; President Nixon; Dr. Eugene Chazov, Soviet cardiologist; Soviet Ambassador Anatoly Dobrynin; and Mr. Train. Following the joint environmental protection meeting, Academician Federov—who is also Head of the Soviet Hydrometeorological Service—and other Soviet scientists were the guests of Dr. Robert M. White, NOAA Administrator, on a visit to the NOAA Data Buoy Office at NASA's Mississippi Test Facility. (Wide World Photo)

Lavoie, Sparks Appointed

Dr. Ronald L. Lavoie has been appointed Director of the Office of Environmental Modification under the Associate Administrator for Environmental Monitoring and Prediction. He has been an Associate Professor at Pennsylvania State University since 1968, and last year was on assignment from there to the National Science Foundation in Washington, D.C., as Associate Director of the Meteorology Program.

Dr. Albert K. Sparks has been appointed Deputy Associate Director for Resource Research in the National Marine Fisheries Service. He joined the Federal service in January 1970 as laboratory director of the NMFS biological laboratory in Galveston, Tex., and was named Director of the Gulf Coastal Fisheries Center in July 1971, when a reorganization of NMFS concentrated the work of several other installations under the Galveston facility.

NOAA AWARDS HONOR SIX; CITATIONS GO TO 19 UNITS

The six winners of the 1973 NOAA Awards are: Dr. James R. Wait of Boulder, Colo.; Walter D. Komhyr, also of Boulder; Dr. Clifford A. Spohn, of Clinton, Md.; William R. Long, of Pittsburgh, Pa.; Bob E. Finley, of Chicago, Ill.; and Morris R. Jones, of Fairfax, Va.

For their outstanding contributions to NOAA programs, NOAA Administrator Dr. Robert M. White awarded a plaque and one thousand dollars to each of them, at a luncheon in Silver Spring, Md.

Dr. Wait, Director of the Environmental Research Laboratories', Theoretical Studies Group, honored for scientific research and achievement, is internationally recognized as a leader in theoretical studies of electromagnetic wave propagation in the earth and its atmosphere.

Mr. Komhyr, Chief of the Geophysical Monitoring Techniques and Standards Group of ERL's Air Resources Laboratories, received the award for engineering and applications development, for creating several instrument systems required for measuring trace constituents in the atmosphere, particularly ozone.

Dr. Spohn, Director of Operations for the National Environmental Satellite Service in Suitland, Md., received the award for program administration and management, in recognition of his outstanding direction of the operations of the national weather and environmental satellite system.

Mr. Long received a public service award for flood forecasts and warnings credited with saving thousands of lives in 1968 in northern New Jersey and again in 1972 in the Pittsburgh, Pa., area.

Mr. Finley received a public service award for pioneering a "new look" in the consumer educational materials produced by the National Marketing Services Office.

Mr. Jones received the public service award for his innovations in distribution of the NOS nautical and aeronautical charts and related publications.

Unit Citations were also awarded to 19 groups of NOAA employees who, through their individual and collective efforts, have made substantive contributions to the programs or objectives for which NOAA was established. Dr. Robert M. White, NOAA Administrator, presented the citations to the various line Directors.

Environmental Data Service recipients were:
—The Marine Geology and Geophysics Group of the National Geophysical and Solar-Terrestrial Data Center, in Boulder, Colo.
—The NGSDC's Seismogram Services Activity.

National Ocean Survey recipients were:
—The Vertical Branch, National Geodetic Survey Information Center.
—The Pacific Tide Party.
—The Officers and Crew of the NOAA Ship *Ferrel*.
—Area Team 4 and Area Team 8, Nautical Chart Branch, Marine Chart Division.
—Geodetic Level Parties G–36 and G–37.

National Weather Service recipients were:
—The low-level sounding unit of the El Monte, Calif., Meteorological Observatory.
—The Weather Service Meteorologists assigned to the FAA System Command Center, Central Flow Control Facility, Washington, D.C.
—The J. F. Kennedy International Airport Weather Service Office, New York, N.Y.
—The Lakeland, Fla., Weather Service Office.
—The West Palm Beach, Fla., Weather Service Office.
—The Weather Service Forecast Office at Jackson, Miss.

These citations arose from Hurricane Agnes, at the time when she was a tropical storm:
—The River District Office at the Weather Service Forecast Office in Raleigh, N.C.
—The Richmond, Va., Weather Service Office.
—The Weather Service Office at Roanoke, Va.
—The Weather Service Office at Trenton, N.J.

The National Marine Fisheries Service recipient was:
—The Northeast Fisheries Center at Woods Hole, Mass.

The NOAA Personnel Division's National Environmental Satellite Service Recruiting Task Force Group received a Unit Citation.

Evelyn J. Fields being sworn in as the first woman black officer in the NOAA Corps. The oath was administered on October 5 by Rear Admiral Alfred C. Holmes, Director of the National Ocean Survey's Atlantic Marine Center, Norfolk, Va. Ensign Fields' mother is holding the Bible.

SEA GRANT SHRIMP PROJECT HARVESTS RECORD CROP

An aquaculture harvest of shrimp from Texas coastal lands reached a record high in 1973, giving promise that the Sea Grant demonstration project will soon lend itself to broad commercial application.

Shrimp farming experiments are being conducted in two areas—the Barney M. Davis Power Station in Corpus Christi, and in ponds near Angleton in Brazoria County. The result of these efforts is a record-breaking yield in Corpus Christi, which surpasses last year's record crop taken at the Angleton ponds.

"We took 2,040 pounds of shrimp from our production unit in September, an additional 2,348 pounds in October, and a third harvest of more than 1,000 pounds in November," said Dr. Fred Conte, Corpus Christi project supervisor and area mariculture specialist. "This more than doubles the Texas record of 918 pounds per half acre set last October (1972) in the Angleton ponds."

A team of mariculture specialists from Texas A & M University began developing shrimp farming techniques in 1969 under the joint sponsorship of the Texas A & M Sea Grant College Program and the Texas Agricultural Extension Service. Progress over the past five years has been rapid, and technology for commercial production of shrimp has been developed.

According to Dr. Jack C. Parker, mariculture program coordinator and system designer, investment analysis based on a 100-acre system looks promising.

Name Swanson, Austin To Bight Project

Commander R. L. Swanson has been appointed Project Manager for the Marine Eco-Systems Analysis New York Bight Project, and Commander Ned C. Austin has been named Operations Officer.

Commander Swanson, who holds both M.S. and Ph.D. degrees in physical oceanography from Oregon State University supervises the team of environmental scientists who are responsible for the project's scientific and technical direction.

Seek Key To Hurricane Cold Wakes

Recent airborne measurements of a little-understood, possibly beneficial phenomenon—the cold sea-surface temperature wake left by some hurricanes—should help scientists explain where and why cold wakes occur, and what their consequences are.

The research flights, conducted by the National Hurricane Research Laboratory and Research Flight Facility, sampled two autumn hurricanes—Ellen in the Atlantic and Irah in the eastern North Pacific.

"Cold wakes may be beneficial in certain areas," says Peter G. Black, a meteorologist with NHRL. "Cold water brought to the surface may be rich in nutrients which may attract enough marine life to create a kind of transient fishery behind the hurricane. For instance, the phytoplankton (drifting microscopic plant life) standing crop near the surface nearly doubled after the passage of a hurricane in the Gulf of Mexico, according to a Texas A & M study carried out some years ago."

Hurricanes are giant heat engines, the NOAA scientist explains, driven by heat carried into the storm by evaporation and conduction from the warm tropical ocean. This upward heat transfer into the hurricane, caused by the violent surface interactions beneath the storm, should result in a somewhat deeper mixed layer (the upper constant temperature layer of the ocean) and a somewhat cooler sea-surface temperature over the areas affected by the storm. But there have been indications from computer models and measurements made in 1971's Hurricane Ginger that changes in sea surface temperature and mixed layer structure beneath a hurricane are much greater than can be explained by evaporation alone.

Apparently, divergence (or spreading) of surface water at and beyond the peak wind region of the hurricane may lead to upwelling of cooler subsurface waters near the storm center of such a magnitude that the thermocline—the persistent thermal boundary between the isothermal mixed layer and much colder lower levels of the ocean—may be brought to the surface.

Tornado Record Set

CRESSMAN LAUDS KANSANS FOR TIMELY STORM ACTIONS

It was the Year of the Tornado in the United States. At the end of November, the National Weather Service had totaled more than 1,000 tornadoes since the beginning of 1973, compared with the previous full-year record of 929, set in 1967.

Yet the large death tolls that usually accompany these vicious storms were not present. In the first 11 months of 1973, only 84 persons had died from tornadoes, compared with an annual average of 114 for the 20 preceding years, when there were far fewer tornadoes.

In recognition of the significance of this low death toll, the National Weather Service participated in ceremonies in two Kansas communities where swift, lifesaving response to tornado warnings was honored.

Said Dr. George P. Cressman, NWS Director, "We are pleased to participate in two 'Appreciation Day' ceremonies in Kansas this month. We salute the Kansans who helped to hold the death toll to a minimum when two long-track tornadoes—potential mass killers—struck intermittently across the north-central part of the state on the evening of September 25th. Although these two tornadoes remained on the ground in Kansas most of the time for 72 and 138 miles, respectively, the death toll in communities along the way was three—instead of several hundred. This reflects storm-warning teamwork at its best. Many lives were saved, I am convinced, by advance preparedness, timely warnings, and swift response."

Ceremony at Elks Club, Clay Center, Kansas, one of two at which National Weather Service honored Kansans for their alertness in tornado warning emergencies. At lectern, Mayor Ray Logan of Clay Center accepts award on behalf of the citizens; others, l. to r., Harold Lowman, Officer in Charge, NWS Office, Concordia, Kansas; Charles Knudsen, Director NWS Central Region; and Karl Johannessen, Associate Director of NWS in charge of Office of Meteorological Operations.

The National Weather Service participated in Appreciation Day ceremonies in Salina, Kansas, on November 26, and in Clay Center on November 27. Community leaders of the two cities were hosts. Representing the Washington headquarters of NWS was Karl Johannessen, head of the Office of Meteorological Operations, accompanied by Charles Knudsen, head of the Weather Service Central Region, and other regional and state officials of the Weather Service.

The ceremony in Salina honored individuals involved in the preparedness, warnings, and response that gave residents of a 44-unit mobile-home court on the southeast edge of the city ample time to take cover in a community storm shelter before a twister shredded their homes at 7:15 p.m., September 25th. Salina public safety officials estimated most of the people in the court would have been killed or maimed if they had not taken shelter. There were about 80 people in the shelter when the tornado hit. Four persons outside the shelter were injured. There were no deaths.

The ceremony at Clay Center, about 50 miles to the northeast, honored the team that alerted that community when a tornado believed to have been a later phase of the storm that hit Salina roared through Clay Center at 8 p.m. The twister left a path of destruction two to four blocks wide and two miles long. Again, there were no fatalities. And again, early dissemination of warnings by TV, radio and law-enforcement officers had done their job.

There were other, equally dramatic episodes elsewhere along the paths of these destructive twisters, and at localities hit by smaller storms in Kansas that night. The Weather Service has estimated there were more than a dozen tornadoes spawned in the state.

Harold Lowman, Official in Charge of the Weather Service Office at nearby Concordia, Kansas, and his staff, were responsible for the warnings issued by the Weather Service.

Discover New Marine Amoebas

An NMFS scientist conducting the first major study of marine amoebas in almost a half century has identified 20 previously unknown species. His research also shows that marine amoebas may prove highly useful as environmental indicators of oceanic pollutants.

Dr. Thomas K. Sawyer conducted a year-long study of free-living (non-parisitic) marine amoebas in Chincoteague Bay, Virginia.

His studies on these essentially unpolluted waters, he believes, will provide information on natural diversity and types of amoebas against which later studies of polluted waters can be measured.

Amoebas are microscopic one-celled animals. Most are harmless, though some cause diseases such as amoebic dysentery. The total number of species of marine amoebas presently known is about 75.

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NOAA at home

At Boulder's Environmental Research Laboratories, science fair marked the day.

At Miami's Atlantic Oceanographic and Meteorological Laboratories, children by the hundreds—and many others too—viewed decompression chamber.

It was Open House under the Big Top at Washington's two-day observance, held at Sterling's Research and Development Center. Approximately 10,000 youngsters were in attendance on School Day; families came the following day. Above, one contingent from the schools.
See story page 60.